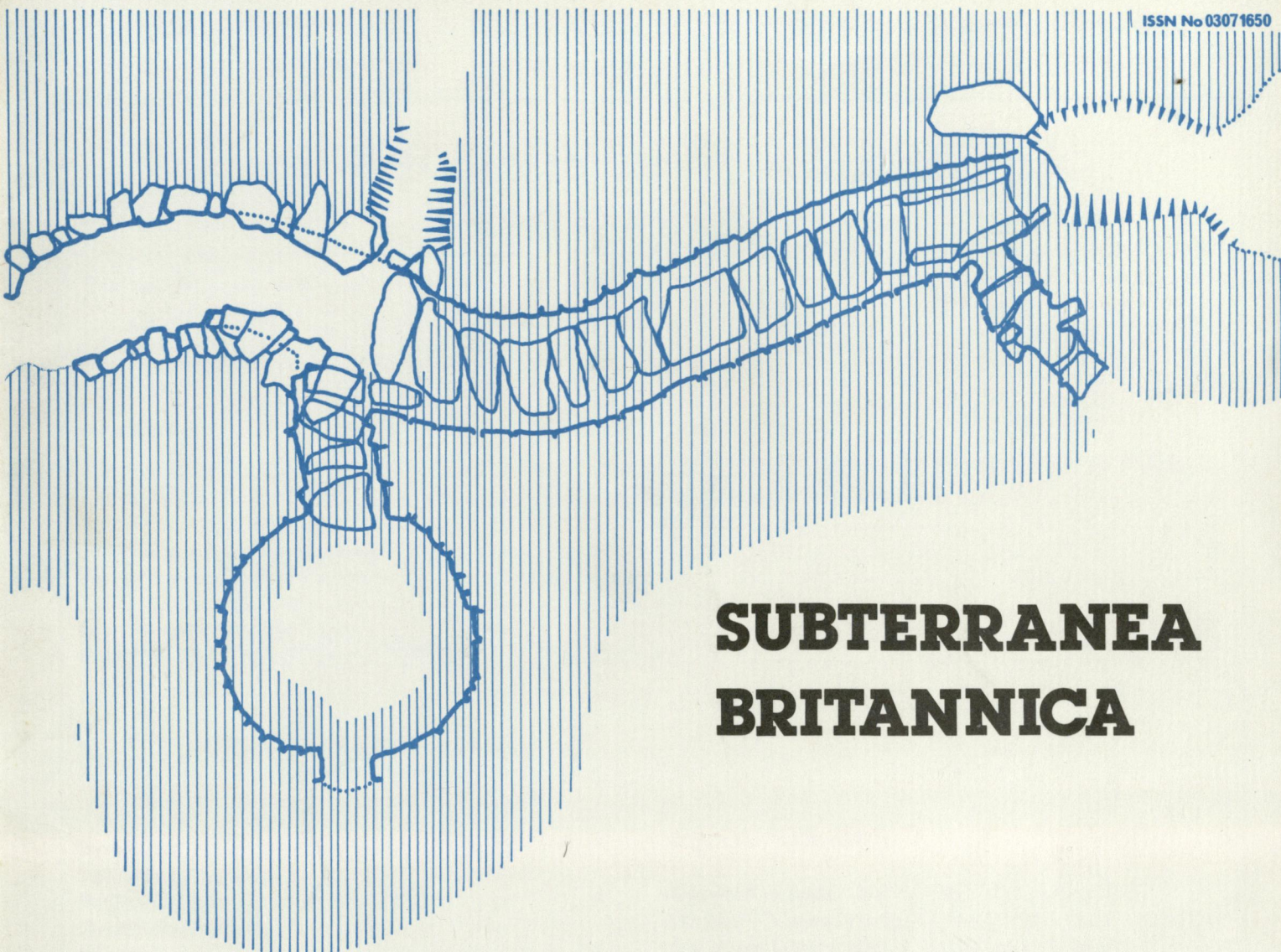




SUBTERRANEA BRITANNICA



Bulletin No. 29

THE BULLETIN OF SUBTERRANEA BRITANNICA

No. 29 - 1993.

Incorporating part 1 of the proceedings of the International Conference at Bath and Bristol, 7-11 August 1992.

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This Bulletin is the official publication of Subterranea
Britannica.

This Bulletin has been compiled and edited by Malcolm Tadd
and Sylvia P Beamon with assistance from Bernard
O'Connor.

BULLETIN 30 - advance notice

This next Bulletin will contain among others, further papers
read at the International Conference in Bath during August
1992
Articles for all Bulletins are welcome from Sub. Brit. and
non-Sub. Brit. members alike and should be sent to Malcolm
Tadd or Sylvia Beamon, 2 Morton St. Royston, Herts. SG8
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Cover Photo: A train which carried coprolite dug at Whaddon, Cambridgeshire, taken to Meldreth station in the last century.
(Courtesy Cambridge Collection.)

EDITORIAL

This issue contains the first two papers commencing the proceedings of the International Conference held in the Bath and Bristol area in August 1992. Further papers will be published in Bulletin No. 30.

The International Conference for 1993 was held in the Czech Republic and a cavern similar in shape to the Royston Cave was a feature of interest at Sloup Castle. Sylvia Beamon was able to note that the Czech cavern was smaller than the Royston one and was similarly, but not so grandly decorated from the medieval period.

Sylvia's researches on Royston Cave, extending over a twenty year period have found fruition in her book published

this year; *The Royston Cave - Used by Saints or Sinners*.

Congratulations to Sylvia who will be talking about her book at the next Day Conference, meanwhile copies may be purchased from her.

At Combe Down, Bath, Halcrows were commissioned to produce a report, taking into account the views of all concerned parties on the stabilisation of the underground quarries. Sub. Brit. was consulted and its views taken seriously. The outcome seems to be that only the most dangerous parts of the underground quarries will be filled and the historic significance of the site will be recognised. Sub. Brit.'s concern about the use of PFA which might cause water pollution problems has, in part, led to an expensive testing of the material.

THE DEPICTION OF UNDERGROUND STRUCTURES ON EARLY ORDNANCE SURVEY MAPS AND PLANS

P.W. Sowan

Research into the original purpose, history, and ultimate extent of underground structures of all kinds is frequently hampered by lack of documentation. Occasionally, however, at least in Surrey, the earlier OS maps and plans can be surprisingly helpful. Although we find no more than 'entrance to subterranean stone quarry', as at Reigate and Godstone on the first 25 inch Surrey sheets, or the rather uninformative 'Devil's hole' at the latter place, we occasionally find a depiction of the form and extent of the subterranean void, in broken lines, as projected upwards onto the ground surface.

Road Tunnels

In the case of canal, railway and road tunnels this was a fairly obvious necessity. The surface parts of these usually public highways and thoroughfares were depicted, and the subterranean connections were almost always as close as maybe to a straight line. Early OS maps could provide helpful evidence for the development of road tunnels. Once the necessity of canal tunnels had been accepted, and the turnpike trusts for road improvements were springing up, the use of short tunnels to reduce gradients and shorten route lengths was only to be expected on the roads. What appears at present to be the earliest public road tunnel constructed was at Highgate Hill in 1809, although this collapsed in 1812 and was converted into an open cutting with an overbridge for Hornsey Lane. The earliest surviving public road tunnel seems to be that at Reigate, made in 1823 on the turnpike road through that town, although the work was funded by the

landowner in this case. Two such short road tunnels still in use in Dorset were made by turnpike trusts - that at Horn Hill on the A 357 from Beaminster to Crewkerne (ST 467 032) and that at Wooton Fitzpaine on the A35 between Axminster and Charmouth (ST 349 948).

However I expect challengers to Reigate to emerge - and perhaps even earlier than Highgate. An interesting clue is provided in volume III of Harley & Donoghue's *Old Series Ordnance Survey Maps of England and Wales*. On page xix are reproduced a number of conventional signs for use on the early OS sheets - including one for the road tunnel, although I have yet to discover such a thing in any of the maps reprinted in that volume, or in volumes I and II. The maps in volume III appear to have been surveyed c. 1789-1822, and it therefore appears the the idea of a road tunnel was not too novel to deserve its place amongst the conventional signs to be used. Can any reader locate any other road tunnels, especially if earlier than Highgate or Reigate? The Park tunnel at Nottingham, the only other definitely public road I know in the country, dates from c. 1855. The Corporation Quarry tunnel at Liverpool, known to have been in use for public access to the spa and ornamental grounds laid out in the disused quarry by 1774 was probably originally a feature of the quarrying operations and may in any case never have taken vehicular traffic - further research is needed here.

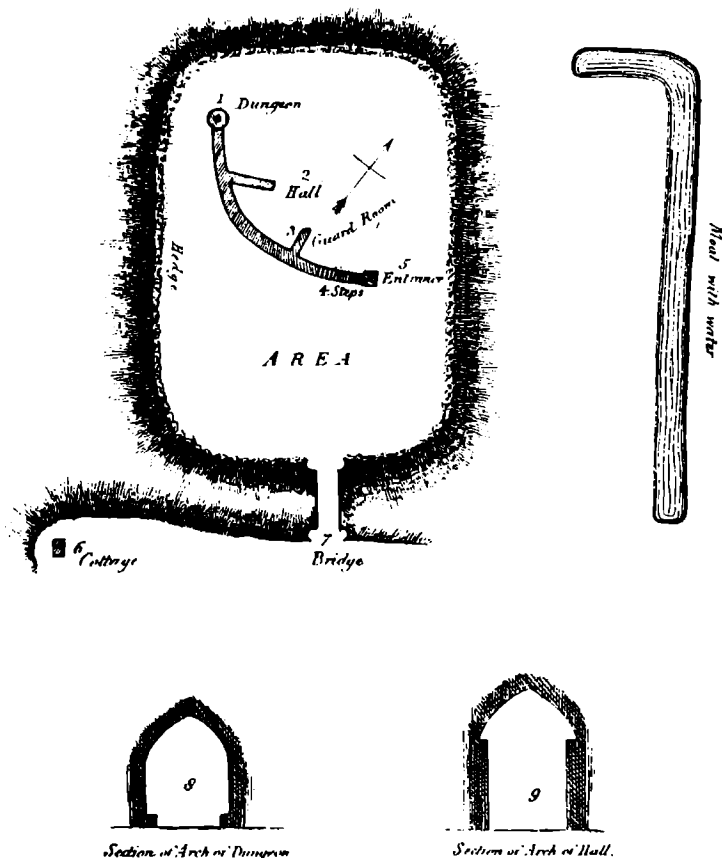
Antiquities

At Reigate the 1872 edition of the 1:500 plan depicts the outline of the 'Barons' Cave under the Castle Mound. But

the numerous, larger and more complex rock-cut cellars and sand mines, some of them even in 1872 of some antiquity, in and around the same mound are evidenced only by the words 'entrance to cave' or 'air-shaft' dotted about. Possibly of course, the policy was to depict subterranean antiquities (the Barons' Cave was described by Camden, 1551-1623) but not operational or recently defunct mines or underground quarries. However at Beddington an intriguing small network of tunnels (the 'Beddington Caves') appear opposite the Plough Inn on the first editions of the 25" plans. (Surrey XIV(9).) Intensive local research has failed to find any positive proof of antiquity for these tunnels in the Thanet Sand before about 1820 at the earliest. Their origin is probably a mixture of garden grotto sand-mine, and rock-cut cellar. The small maze of passages just inside the entrance is accurately shown - access has been possible in recent years and resurvey confirms the OS depiction. However an in all respects highly improbable long straight tunnel - the sort no English parish history is complete without! - is shown on the OS sheets, heading due south and apparently terminating presumably quite coincidentally, below the cutting of the Croydon and Epsom Railway. Did such a tunnel ever exist? On geological grounds alone it is improbable, as it would have involved tunnelling through the geological boundary from Thanet Sand into Upper Chalk. Can members point to other

examples of oddities of this kind being shown on OS Sheets? Lee & Russel, writing in 1924, on the Guildford Chalk Caves (*South Eastern Naturalist & Antiquary for 1924*, pp. 63-64 + plate), inform us that 'In that year, 1868, Captain James was engaged in making a large scale map of the immediate district for the Ordnance Survey, and wishing to determine the position of these caves instructed Corpl. Rob. MacDonald, his subordinate, to search them.' The entrance being discovered, blocked with loose chalk, he had it cleared and the underground galleries surveyed - the survey is reproduced as a sketch. Presumably this, too, was depicted on the published sheet, although as I do not have access to this sheet I cannot say. This despite the fact that informed local knowledge has generally been in no doubt this was a relatively recently worked quarry for hard chalk for building stone (the Guildford stone used by Wren in St. Paul's, for example, as well as its use locally in the castle walls and in domestic interiors.) Grose's *Antiquities of England and Wales 1775* contains a well-known plan and engraving of this site entitled 'Quarry Holes', and the street-name Quarry Street still reminds us of the excavation's purpose. Before the Quarries Act of 1894 confused things, an open chalk pit was usually called a pit, not a quarry, which was for squared stone for building.

BARON'S CAVE - SUBTERRANEAN CHAMBERS OF REIGATE CASTLE (*Gentlemen's Magazine Vol. XVIII 1842*).



THE WATER SUPPLY OF BRIGHTON AND HOVE

Tim Martin

The main development of the public water supply in Brighton and Hove started in 1834 with the formation of the "Brighton, Hove and Preston Waterworks". At the time of the 1841 census the population was just over the 100,000 thousand for all the four local parishes. The water works company first had a 20 hp rotative beam pumping engine at its Lewes Road site built in 1836. This supply was intermittent and inefficient for the local needs and was supplemented by small privately provided wells and pumps on a house by house or group basis.

The largest of these systems provided stand pipes just east of the East Pier for the poor in the district. This was provided by John Cordy Burrows along with the dolphin fountain at the Old Steine by public subscription in 1846. The deepest well dug by hand in the UK is a well at Warren farm which was sunk in 1862 to a depth of 1285 feet at a cost of around £6,000. Another well worth mentioning is one at Saddlescombe farm which is 240 feet deep. It had water drawn up using a donkey wheel tread mill and ceased use in 1899.

The first sewer of any size ran through the Old Steine next to the fountain as a large tidal sewer. It was constructed in the 1840s and discharged about fifty yards out to sea to the west of the pier and was continually flushed out by the water flowing out from the top of the system from the springs at Patcham which ran as an open water course to the sea until

the 1840s when it was enclosed and took on the function of a sewer. This was re-aligned in 1874 to discharge in Peacehaven.

The first water company to be formed was the "Brighton, Hove and Preston Waterworks Company" set up in 1834 to supply Brighthelmstone, Hove, Preston, Ovingdean and Rottingdean.

One of the early ideas which was abandoned was to cut a tunnel from the foot of the Dyke and feed by gravity water into Brighton. Instead, a beam engine and well were constructed at the Lewes Road site.

In 1853 the Brighton, Hove and Preston Constant Service Water Supply Company was formed which by 1861 was supplying 82,000 people with water. At this point a new pumping station at Falmer with a 130 hp Woolf Compound Beam Engine by Eastons Amos and Sons was installed. In 1866 the No 1 beam engine at Goldstone was opened with a 120 hp Woolf Compound condensing beam engine.

By 1872 this was proving inadequate and the Brighton Water Corporation was formed to take over all responsibilities for supplies. They had the No 2 beam engine built which is a 250 hp jet condensing Woolf Compound Engine by Eastons and Anderson. Their combined capacity was the providing of four and a quarter million gallons of water to a total head of nearly 400 feet per day. These Beam engines at Goldstone Pumping Station were run with boilers until 1934

*Fig. 1 FISSURE AT
1200 FEET WEST
OF WINDING
SHAFT AT MILE
OAK PUMPING
STATION, TAKEN
1949.
1900 TUNNEL IN
BACKGROUND.*



when they were replaced with the 4 boilers now present in the museum. The first beam engine went out of service in the 1940s with the introduction of electrical pumps and much of the machinery was scrapped leaving some curious puzzles in the well shaft for us today.

We know the main well was not accessed by ladder at the time of the beam engine's use because the access well was to the left of the main shaft, behind the brick lining of the main well accessing the main well at a point 20 feet down the shaft.

The shaft contained large support frames. The frames were centred up at each side with wedges in the cast iron housings in the walls. From the precision with which they are formed it is possible that the pump rods originally passed to the bottom inside the rising mains pipes. This method makes maintenance of the foot valve and plunger very difficult as they would have to be withdrawn to the surface some fifty metres above or, alternatively, have access panels in the pipe at the bottom - or should I say the last bit of dry land which is a small stage.

It can be seen from the detail of the guide support that it was a very large and sophisticated casting positioned with some precision. Under the water in the well the remains of a 12-14 inch pipe can be seen passing from the base of the well up the north facing heading. This has a large valve just before it passes into the brick lined heading.

On the south side of the well is a smaller brick lined tunnel which is in the direction of the No 2 Engine. There is a similar shaped tunnel from No 2 in the direction of No 1 well.

The following account is taken from "Present practice of sinking and boring wells" by E. Spon 1885.

"Brighton - this town has always been supplied from wells sunk in the chalk. One well sunk near the Lewes Road has a total length of 2400 feet of headings driven in a direction parallel with the sea and at about the coast level of low water. These headings intercept many fissures and materially add to the yield. A second well was sunk in 1865 at Goldstone Bottom and headings driven to the extent of about a quarter of a mile across the valley parallel to the sea. Goldstone Bottom is a naturally formed basin in the chalk, the lowest side of which nearest the sea is more than 60 feet higher than the middle or bottom of the basin. The water is obtained as at Lewes Road, from fissures generally running at right angles to the coast line, but they are of much larger size and at far greater distance from each other. At the Lewes Road well it is rare that 30 feet of headings were driven without finding a fissure, and the yield of the largest was not more than 100-150 gallons a minute. At Goldstone

nearly 160 feet were traversed without any results and then an enormous fissure was pierced which yielded at once 1000 gallons a minute; the same interval was found between this and the next fissure which was of a capacity nearly as large. The total lengths of the headings at Goldstone Bottom is 13,000 feet, the yield from each well is about 3,000,000 gallons daily"

As the headings and adits are all flooded the above account is all we can glean from the system, there being no maps surviving of the tunnel layout. The tunnels must have been mapped as in June 1991 the Engineerium was contacted by a solicitor acting in the conveyance of a house some half a mile north of the pumping station, requesting information about a tunnel from the Goldstone Bottom pumping station under the property he was conveying and which was listed on the 1883 conveyance.

Goldstone pumping station was one of very few pumping stations to use ozone as a powerful bacterial agent. It was produced with an electric generator and injected into the water. The scars of the plant room for this can still be seen on the north side of No 1 engine house.

The West Brighton Waterworks Company Limited whose pumping station was new Hove Station also provided salt water supplies to a number of properties along Grand Avenue in Hove. In 1876 this water company was purchased by Brighton corporation who then supplied salt water to up to 100 properties until the outbreak of the second world war when it ceased due to the minefield planted on Hove lawns by the Royal Engineers. In 1876 the pump engine which ran on compressed air was converted to run on water as the pumping station supplying the air was not included in the sale to the Corporation. The basic arrangement was to use the pump at high water on spring tides (every two weeks) to fill a storage tank and then to use the pump each day to fill the water tanks in each property.

References

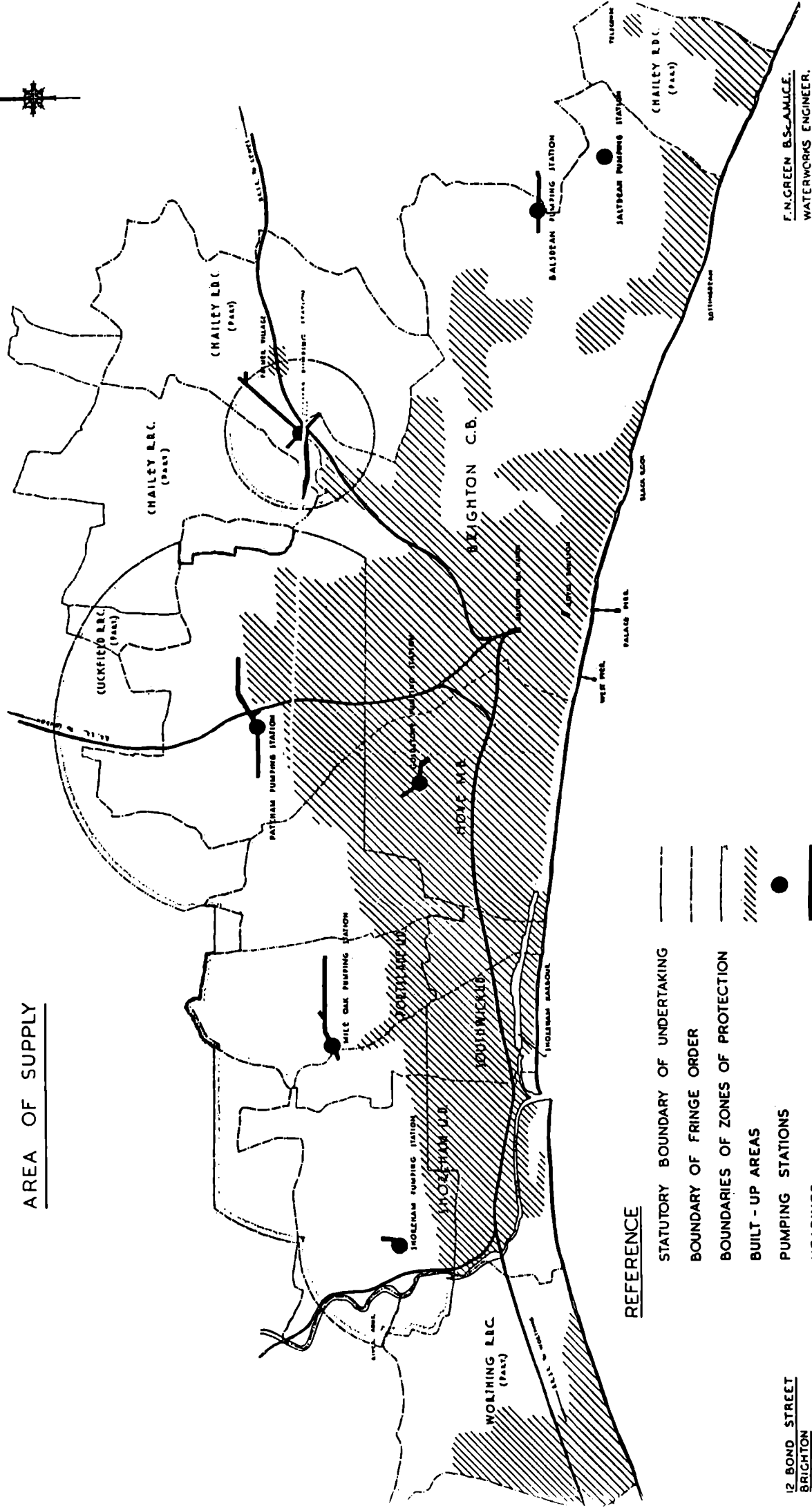
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Tim Martin is Surveyor at British Engineerium, Hove

The beam engines of the Goldstone Pumping Station can be seen in steam on most Sundays and Bank holidays at the British Engineerium, Nevill Road, Hove. The museum is open seven days a week from 10-5pm. Telephone 0273 559583

F. N. GREEN BSCAMICE.
WATERWORKS ENGINEER.

AREA OF SUPPLY



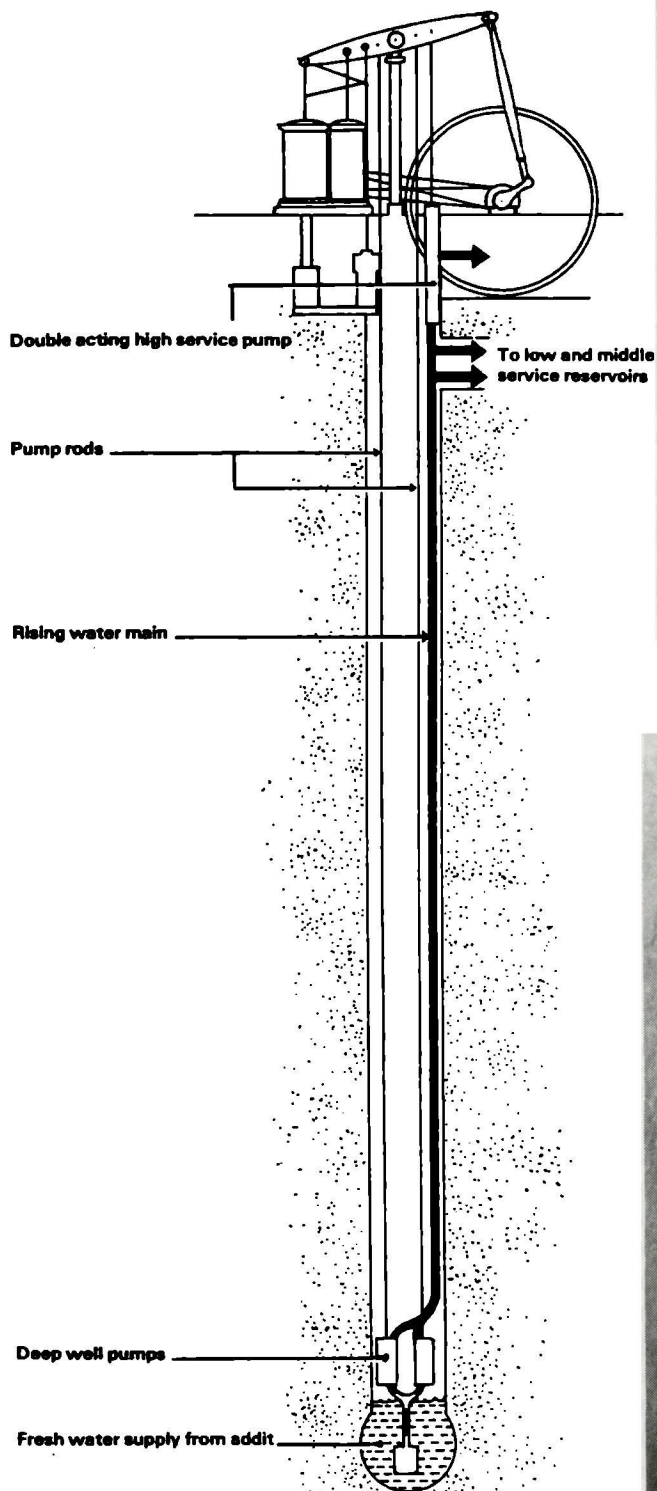


Fig. 3 SECTION OF 'NO. 2' ENGINE AND THE WELL WHICH, LIKE 'NO. 1', IS A 12 FOOT BY 9 FOOT OVAL BRICK STRUCTURE 150 FEET DEEP BELOW THE ENGINE. THE WELLS ARE SUPPLIED BY TUNNELS REACHING OUT TO BEYOND HOVE PARK TO THE NORTH AND WEST.

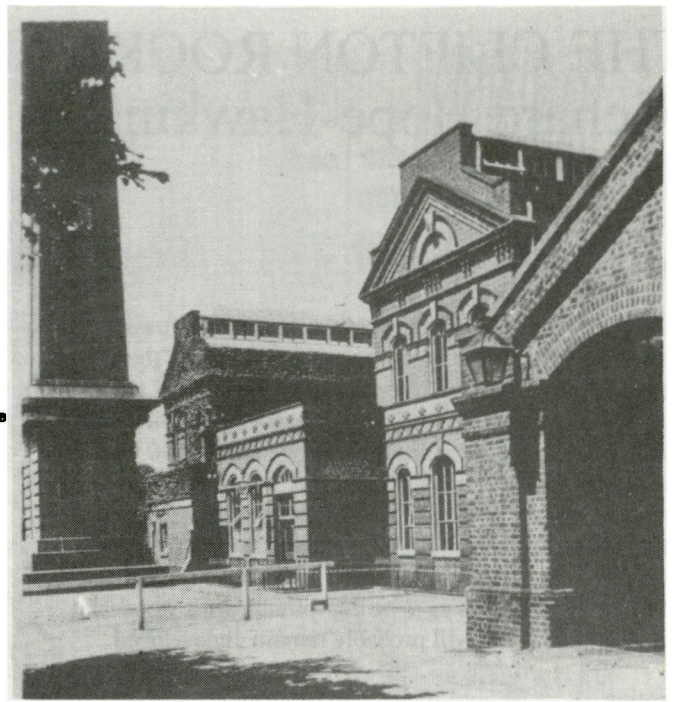


Fig. 4 VIEW OF GOLDSTONE PUMPING STATION, c.1920

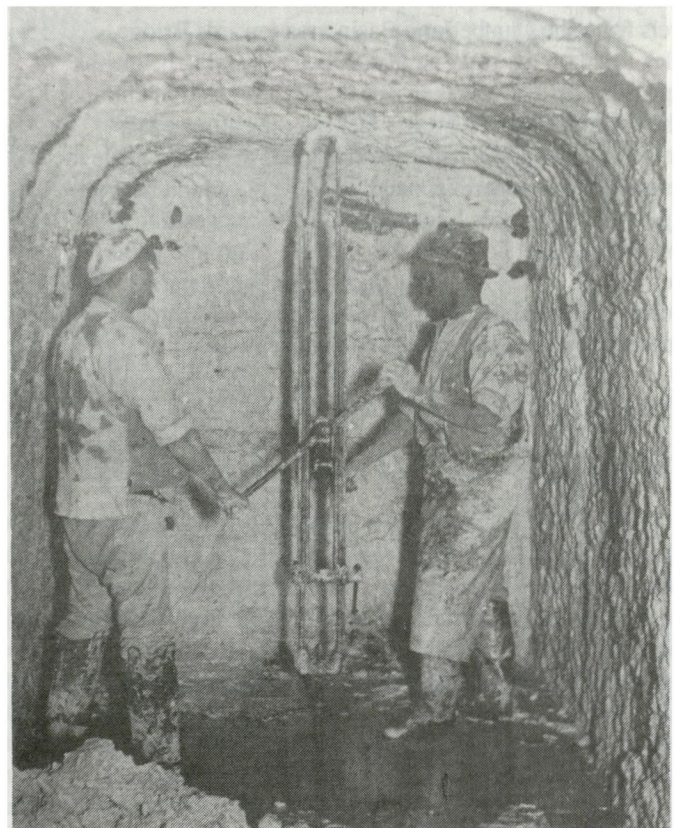


Fig. 5 PHOTOS OF HAND AUGURING FOR USING EXPLOSIVES TO PROCEED TUNNEL. ONE OF FOUR PHOTOS PRINTED ON ALBUMEN PAPER WHICH WOULD DATE IT TO 1880-1910. DESCRIBED AS HEADINGS AT MILE OAK, POSSIBLY THE 1900 HEADING TO THE EAST. SEE NEEDHAM GREEN'S MAP.

THE CLIFTON ROCKS RAILWAY, BRISTOL

Richard Hope-Hawkins

The Clifton Rocks Railway

A forgotten engineering masterpiece; most of us pass by the Clifton Rocks Railway without even knowing it is there. Constructed with great difficulty inside the cliffs of the Avon Gorge in order to reduce its visual impact on the picturesque surroundings, this funicular railway operated for 40 years against diminishing trade. Its closure before the WWII did not mark the end of its useful life as it became a secret transmission base for the BBC. Now a disused shell, with access so difficult that any potential scheme to revitalise it would be so expensive as to be unprofitable, this wonderful relic of a bygone era will probably remain undeveloped.

Location

Many people remark upon the strange 'house - like' facade set into the cliff which can be seen from a motor car as one travels from the Cumberland Basin area towards Bridge Valley Road on the right hand side before passing below the Suspension Bridge. This facade is the lower station entrance of the Clifton Rocks Railway. Behind the entrance is a tunnel cut through the rock which extends at a steep angle to emerge in the now derelict small triangle of ground between the junction of Princes Lane and Sion Hill, adjacent to the Avon Gorge Hotel. Within this triangle of ground is the upper Station which has long since fallen into a state of disrepair. The tunnel itself forms a straight and direct connection between the upper and lower stations.

A Description Of The Original Railway

The Original Tunnel

The tunnel is 500 feet long, semi elliptical in cross section with a roof height of 18 feet and a width of 27 feet 6 inches it climbs a vertical distance of 240 feet on a rising gradient of about 1:2.2, that is a vertical rise of 1 foot for every 2.2 feet of forward travel. The tunnel was blasted and cut through badly faulted limestone and was brick lined in almost its entirety with a wall thickness of 2 feet. Although the tunnel was lit by daylight at both top and bottom, this was supplemented by gas lamps installed down the tunnel length.

The Upper Station

From the surface the upper station appears to be a small single storey building, triangular in plan, with a facade of ashlar bath stone faced masonry construction facing Princes Lane and the Avon Gorge. The Sion Hill elevation consisted of iron railings between masonry piers: the railings are now

covered with sheets of boarding. There are two entrances to the upper station, one at the junction of Princes Lane and Sion Hill, the other onto Sion Hill itself.

The Sion Hill entrance had an ornamental iron arch over. A visitor would descend down steps from either entrance to the top station into a small platform which was below upper street level. In fact the platform extends under the pavement in Sion Hill, and a series of small arched roof vaults between the rock face and a substantial steel beam, itself supported on cast iron columns, support the pavement of the street above. The remainder of the 15 feet wide platform which is not recessed under the pavement was covered with an awning of small glass panels set in iron frames (pavement lights) forming a floor on which sightseers could stand and take in the view, or watch the cars ascending and descending the tunnel. Most of these glass panels are still in place, but the grid of supporting steelwork in which they are mounted is in poor condition. At the head of the tunnel was a timber screen, pay box and turnstiles, together with the two large pulley wheels described later in this chapter.

The Lower Station

The lower station itself is constructed inside the rock, and was finished with the facade erected flush with the rock face. This facade was of rubble construction using grey pennant stone, locally mined and used extensively in the less expensive houses being built in Bristol in the 1800's. Quoins and architraves were of bath stone with three decorative gargoyles above the three entrance arches, the two windows, one on either side remaining undecorated. A verandah was originally incorporated but was later removed, the six smaller arches of the upper floor being retained as picture windows giving a superb view across the river, with a tiled timber canopy above to provide shade. The building behind this facade was of two storeys and the ground floor consisted of two rooms. One contained the turnstiles and pay box (now removed) set in a floor of red 6 inch tiles. The walls of this room were lined from floor to ceiling with vertical pine matchboarding. The other room was undecorated and contained the pumping machinery. On the second floor was situated a small toilet installed in September, 1894 and some staff facilities. A later addition above the entrance portals were three bath stone lintels with the legend 'Clifton Rocks Railway' carved in.



Fig. 1 GENERAL SKETCH OF THE CLIFTON ROCKS RAILWAY

The Original Mechanical Plan

The Cars

From the day that it opened the line was operated by four cars. Each car consisted of an upper passenger section, with a triangular chassis angled to suit the gradient of the tunnel. The upper passenger section resembled in appearance the horse-drawn tramcars to be found operating during the 1890s on the City tramway, and are believed to have been constructed in Birmingham by Starbuck who built tramcars for the City. Each car could accommodate 18 seated passengers and had sliding doors at either end, the door at the end facing the river opening onto a small platform on which the 'brakesman' or attendant rode alongside the brake control. Cars were painted light blue and white with gold lining when new, but were later re-painted in colours similar to the Bristol Tramway Company. The cars were mounted by four leaf springs onto the chassis which were built by Messrs Gimson of Leicester. These four chassis were part of a batch of six ordered on 7 March 1892 and delivered in December, 1892. The balance of the order was for the Bridgenorth/Castle-Hill Railway, those for the Clifton Rocks being designated by a C prefix on the detail drawing. The Bridgenorth equipment had a wider gauge at 3 ft 8 ins. The chassis were constructed of 8 in by 3 in steel channel section 14 ft 6 in long, carried on four wheels. The only item not manufactured at Leicester within the chassis were the axles which were supplied by J.H. Lloyd and Co. The axles ran in brass bearings fitted onto cast iron housings bolted onto the top side of the bottom chassis member. The cars were handed left and right.

The Rails

Cars ran in pairs on adjacent tracks of 75-80 lbs/yd flat bottom rail. These rails were bolted directly onto concrete cross sleepers the width of the tunnel at 5 feet spacing firmly bedded in the rock bed of the tunnel. The gauge of the railway was 3 feet and each pair of tracks either side of the tunnel were at 5 feet 6 inch centres.

Operation of the Carriages.

Each pair of carriages was connected together via two steel wire cables 'being 30 times stronger than the load that has to be put upon them' which turned around large pulley wheels at the top of the tunnel. The principle behind the operation of the cars is known as 'water balance'. As one car ran down its rail its companion car would be pulled up, the weight of the water plus passengers in the descending car overbalancing the weight of the passengers in the ascending car. Mounted in the frames beneath each passenger section was a tank of 12 gauge steel bolted on 3 inch x 1.5 inch rolled steel joists and fitted with a lid of 18 gauge steel. At the beginning of a journey, releasing the brakes on both cars allowed the top car to descend, pulling the bottom car up in doing so.

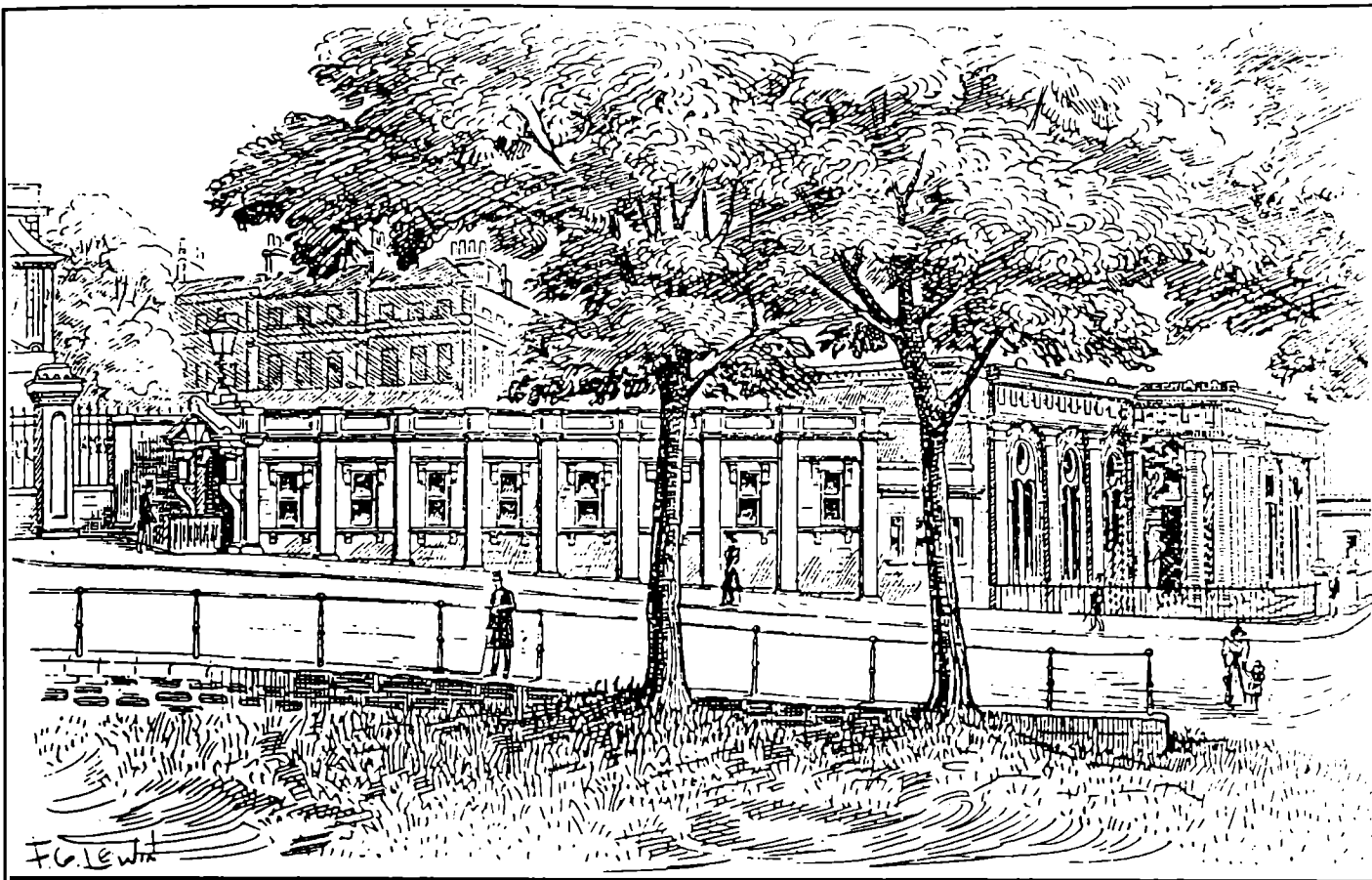
Equipped with all 'mod cons', an electric telegraph manufactured by King, Mendham & Co. of Bristol, permitted the brakesman of the car at the bottom to inform his opposite number in the car at the top of the number of passengers to be raised. By this means, the correct weight of water required to balance the load could be added to the top car. If the ascending car was empty, then the weight of passengers in the descending car (if full) was sufficient to activate the system without the water tank being filled. Upon completion of the journey and whilst the passengers disembarked, water in the tank of the car at the base of the incline was automatically emptied into a sump before being pumped back up to a reservoir at the head of the incline by duplicate sets of pumps powered by self starting 'Otto cycle' gas engines manufactured by Crossley of Manchester. The water which was employed to operate the line was therefore used over and over again, the cost of the motive power for working that required to drive the gas engines for pumping the water.

The Brakes and Speed Governors

The design of the system showed a great concern for safety: some might describe the design as 'belt, braces, piece of string and the Royal Air Force'. This is amply demonstrated in the superb braking systems which were arranged 'such as to satisfy the requirements of the most nervous of passengers'.

Duplicate brakes were incorporated, operated by hydraulic pressure and acting on both sides of the rails of the line. Another set of duplicate brakes were incorporated for arresting the speed should the cars for any undue cause exceed their proper pace and a third set of duplicate brakes were also incorporated for automatically stopping the cars should either of the other two systems fail, or should the two steel ropes break at the same time.

The hydraulic brakes acting upon the rails were the ones controlled by the brakesmen. They were designed such that the brakesmen had to give their attention to prevent the car from stopping, rather than trying to make the car stop. Thus, should one brakesman become careless or lose his hold of the brake windlass handle, both of the cars would immediately stop, even though the brakesman upon one of them might be unaware of the problems which had befallen his companion. The hydraulic brake mechanism consisted of hydraulic rams acting into cast iron blocks which gripped the rails in a 'callipe' action. The rams were connected by copper tubes to much larger master cylinders, the hydraulic fluid being water. Pressure on the system was applied by heavy weights acting on the top of pistons in the master cylinders. The weights were directly connected to the conductor's windlass hand wheel. The act of turning the windlass hand wheel would raise the weight from the top of the master cylinder reducing the pressure in the system and hence the grip of the cast iron blocks on the rails. Should either conductor release his hold on the handle for any reason, the weights would automatically drop back under gravity,



*Fig. 2 THE SPA EXTERIOR, AND
CLIFTON ROCKS UPPER STATION*

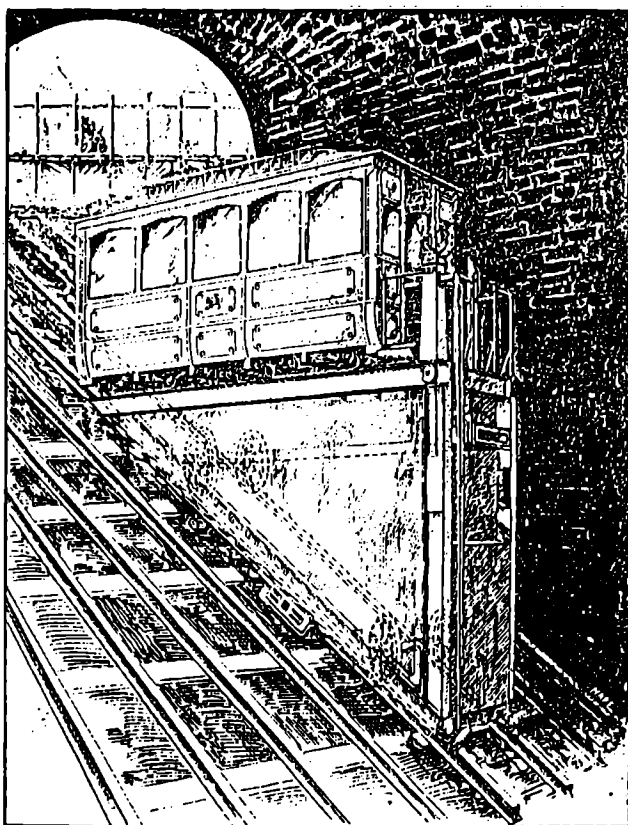


Fig. 3 THE CAR

The axles ran in brass bearings fitted onto cast iron housings bolted onto the top side of the bottom chassis member. The cars were handed left and right.

increasing the pressure in the system, applying the brakes and bringing both cars to a halt.

The speed governing brake acted independently of the controlling brake to cause the hydraulic pressure to be increased and the rails to be gripped should the recommended speed be exceeded. How it worked is not clear, but from the general specification it appears to have been operated by means of an eccentric on the lower axle.

The third system of brakes which would operate in the event of a cable failure was completely automatic. It consisted of two large cast iron wedges with serrated faces mounted inside either rail, on the ends of steel arms, both of which were pivoted on a heavy steel cross member. Both ends of the cross member enclosed the rails. The free ends of the arms were attached to the two cables, and a large coil spring was incorporated held under compression by the tension in the ropes. In the event of a cable failure, the load on the spring would be released and the spring would pivot the arm jamming the wedge between rail and cross member. Deflection of the rail was prevented by the outer ends of the cross member. Thus the design incorporated fail-safe systems which were made simple and which were also duplicated throughout the assembly: a very reliable design concept.

Construction of the Tunnel

At the time of construction the tunnel was the widest of its kind in the World. Being brick lined, the timbering necessary to provide temporary support during construction was built in above the bricks, which incidentally were set in cement. Construction of the tunnel started from both ends and from intermediate shafts down its length. Steam power was used to provide compressed air for the rock drills for hauling away excavated rock, and was the power for the pumps used in draining the workings from the ever present seepage of surface water. Considerable difficulties were encountered with the tunnelling due to the faulting in the limestone, and rock falls (both inside and outside of the tunnel) were a constant source of worry and delay. Even as late as six weeks before the opening, a rock fall of some 20 tons down the outside of the rock face on the 31st of January, 1893 demolished a portion of the miniature wooden verandah which formed part of the design for the bottom entrance to the railway, just missing a City bound horse-tram that was passing. Apart from the looseness of the rock causing problems in the construction, the limestone in some cases was found to be so conglomerated with other metalliferous rock 'as to break the drills and turn the edges of the tools that were used for boring'. The scaffolding of the tunnel was a matter of great difficulty to the Contractor, and the greatest caution was necessary when erecting the complicated centre pieces and when placing in position the immense amount of timber required as struts for the roof and sides of the cutting. On account of the steep incline, it was impossible to arrange

gangs of men to work one above the other simultaneously, and it was very difficult to provide for the dislodging of the material above without choking the entrance below. Intermediate shafts were used to remove dislodged rock via winding engines and machinery erected above the ground. Men were brought from Canada to operate the pneumatic machines as suitably skilled labour was not available in Britain. There was considerable difficulty in keeping the men at work for more than a few weeks at a time, various accidents causing them to become nervous. The work originally scheduled to be completed in 12 months, actually took two years to finish, but great celebration occurred when H. C. Hayes, the Contractor's 10 year old son, squeezed through the hole when the two headings joined and found the shafts lined up perfectly. Construction costs had been anticipated at £10,000, but in fact with all the problems, costs rose to over £30,000.

Timetable of Operation

The following is a timetable of operations dated January, 1922, which was almost identical with that of the first week of operations:

1 June - 30 Sept	Weekdays	8.30 am - 10.00 pm
	Sundays	2.30 pm - 10.00 pm

1 October - 31 May	Weekdays	8.30 am - 9.00 pm
	Sundays	2.30 pm - 9.00 pm

By September, 1928 the timetable had become:

All year round	Weekdays	8.45 am - 9.15 pm
	Sundays	2.30 pm - 9.15 pm

Ticket Prices	Upward	Downward	Ret
On the day of opening:			4d
1893	1d	0.5d	
1906	2d	1d	
1928 - People	2d	1.5d	
Mail cars and bicycles	3d	2d	

The Conception of the Clifton Rocks Railway

In the mid to late 19th Century, Clifton, Bristol and Hotwells, were considered as separate. Clifton was a posh area. Hotwells, no longer a spa attraction was very down market, the River Avon a stinking open sewer, and the inhabitants including a substantial number of lower class drunken mariners due to the abundance of ships in the harbour. The residents of Clifton really did not particularly want ready access to their domain made available to the surrounding

population. For some time they even resisted having trams use their streets.

This then was the back drop to the conception of the Clifton Rocks Railway. The only way to get from Hotwells to Clifton was via a variety of steep hills, such as the zig zag path which remains with us today, or Granby Hill.

Thus the Clifton Rocks Railway owed its existence to the self imposed isolation of the elegant and fashionable residential area of Clifton from the developing public transport system of the City of Bristol.

Historical Diary

The Proposal

23rd July, 1880. Mr George White, founder of the Bristol Tramway Comp and later founder of the Bristol Aeroplane Comp made an alternative proposal for an inclined railway from the north end of the Suspension Bridge down the face of the Avon Gorge to Hotwells. Here a connection would be made with the City Tramway, with the Hotwells terminus of the Bristol Port & Pier Railway and its services to Beach and other suburbs of Bristol, and with the Hotwells landing stage from which P & A Campbells and others operated their pleasure steamers to the exotic charms of Ilfracombe and the South Wales ports. Such a project was rejected by the Society of Merchant Venturers, owners of the cliffs, probably because they thought it would be such an eyesore.

27 September, 1889. A similar application from a Mr Kincaid was also rejected by the Society of Merchant Venturers.

26 September, 1890. A proposal was placed before the Society from Mr George Newnes MP for an inclined lift from Hotwells Road to the garden of no. 14 Princes Buildings. Princes Buildings is the row of houses which now incorporates the Avon Gorge Hotel. This time the proposal was for a railway running not up the cliff face, but through the rock in a tunnel. The Society of Merchant Venturers, being prepared to consider this scheme, resolved to confer with Engineers.

The Individuals Involved with the Development

The promoter, George Newnes, was a Member of Parliament for Newmarket, Cambridgeshire, from 1891 to 1895, founder of the Newnes Publishing Company and was created a Baronet in 1895. His country residence at Hollerday Hill, Lynton, Devon, brought him into contact with the Lynton/Lynmouth Cliff Railway, and a business association began between Mr Newnes and the eminent Engineer who was responsible for the Lynton/Lynmouth Cliff Railway and similar projects elsewhere, namely Mr G Croydon Marks AMICE, MICE. The Architects appointed for the project were Philip Monroe & Sons of Baldwin Street, Bristol and the Civil Engineering Contractor Messrs C A Hayes of

Thomas Street, Bristol were employed to carry out the construction of the tunnel.

The Society of Merchant Venturers evidently were only prepared to consider the construction of the tunnel and railway, providing that Mr Newnes also tried to resurrect Clifton as a spa town by constructing a Hydropathic Institute adjacent to the proposed upper station. (For further details refer to the section on 'The Hot Wells') The total cost of the railway was estimated at £10,000 and Mr Newnes was the sole financier for the venture.

31 October, 1890. The Society of Merchant Venturers resolved to consent to the project on the following terms :

- (a) That rents would be raised.
- (b) That the works should be finished by January, 1893.
- (c) That no alteration should be made to the exterior elevations of the buildings to be constructed, and that they should be used for no other purposes than permitted at the Bath Pump Room.
- (d) No licence for liquor
- (e) That the road adjacent to Princes Buildings should not be obstructed (Princes Lane).
- (f) That no blasting should take place between 7.00 pm and 7.00 am.

7 March, 1891 Lady Wathen, Wife of the Lord Mayor, Sir Charles Wathen, fired the first shot for the tunnel excavation, an event that was accompanied by the usual luncheon and speeches.

After a difficult and expensive construction operation which had not been anticipated, the railway was ready for opening considerably later than had at first been planned.

Early Operations

11 March, 1893 was the date of the official opening of the Clifton Rocks Railway. 6,220 people made the return journey and the promoters of the project must have felt greatly heartened by the way in which the public took to their development. In the opening period around 11,000 passengers per week were carried, 427,492 passengers in the first 12 months of operation. Unfortunately this was really the peak of operations for the railway and numbers subsequently declined steadily.

The ticket for the first travellers opening day was a commemorative gilded metal medallion in the shape of a Maltese cross having on one side a representation of one of the cars together with the initials of the promoter, engineer and architect. On the reverse was a commemorative inscription.

27 October, 1893 The Society of Merchant Venturers, being notified that the railway had been operating for six months, resolve that the Deeds be executed in favour of Mr Newnes for a period of 999 years, with a Covenant under which the lessee must maintain the tunnel in proper repair.

Spring 1894. Mr Newnes formed the Clifton Rocks Railway Co. Ltd to operate the line. Chairman of the Board was Mr

Newnes himself with Mr Croydon Marks a Co-Director along with P. Fussell and A Yeatman (Company Secretary). Solicitors for the company were Osborne, Ward, Vassall & Co Bristol. To this company was leased the tunnel for an annual rental of £50 subject to covenants requiring the company to maintain the tunnel with the lines, stations, etc., fit for use as a railway tunnel.

1903. A dispute arose between the City of Bristol (Plaintiffs) and the Clifton Rocks Railway Co Ltd (Defendants). The City claimed that the Clifton Rocks Railway occupied land which was owned by the City. This was a small triangle of land which included The Hot Well pump within the same parcel and was situated at the lower station, on the side most remote from Cumberland Basin. The infringement of the tunnel on this piece of land was no more than 10 feet at the absolute maximum. The Clifton Rocks Railway Co. replied that they thought they owned the land, but the lost their case and had to pay a small sum to the City in compensation,

The Decline

1908. The steady decline of passengers took their toll and a receiver was appointed.

29 November, 1912. The railway's assets were bought outright by the Bristol Tramway and Carriage Co, for the sum of £1,500.

5 July, 1913. The Royal Show was held on Durdham Downs and during a 'flash in the pan' surge of use, 14,500 people used the railway during the week prior to this date.

1922 The Portway road was widened. This involved the closure and demolition of the Bristol Port & Pier Railway from Sneyd Park junction up to and include the Hotwells terminus, which must have been a good connection for the Rocks Railway, being situated just a few hundred yards away, in the Avonmouth direction. A major road was now placed only inches from the bottom station which made access most difficult.

1 October, 1934. After continued deficits, the Clifton Rocks Railway finally closed, the four cars being lowered to the bottom station.

1937. Bristol Corporation received an interest in the tunnel via the Bristol Transport Act 1937.

Use of the Tunnel During the Second World War

At the outbreak of the Second World War the Ministry of Works and Buildings took a tenancy of the tunnel from the Tramways Company at a rent of £100 per annum subject to conditions which required the Office of Works to indemnify

the Tramways Company against any breach of the covenants in the lease under which the Tramways Company held the property.

25 March, 1940. British Overseas Airways constructed an office suite and used part of the upper section of the tunnel for storage.

Control of the tunnel came under the ARP (Air Raid Precaution) Committee which later became the Civil Defence Committee during the War, where they established shelter number 1898.

The BBC needed to keep broadcasting through the Second World War to try to distract an estimated audience of up to six million people away from the blatant propaganda of William Joyce, an American born, English educated fascist whose exaggerated upper class accent soon earned him the nickname 'Lord Haw Haw.' The Nazis had craftily set up what they called a 'British Forces Service' which had dance music interspersed with news. Military Chiefs who, prior to the War were demanding that the BBC be closed down if and when War broke out were beginning to see the sense in keeping the BBC on the air, and some sophisticated technical changes were made to prevent BBC transmitters becoming beacons which would guide enemy aircraft to their targets. The BBC had to face up to the fact that Broadcasting House might be badly damaged by bombs or even taken over by invading Nazis. They decided to set up an emergency headquarters in Bristol, capable of handling programme production if the need arose. Since however, this station too could have come under attack, the search began for bomb proof premises. The disused railway tunnel of the Bristol Port & Pier Railway was earmarked. Despite the emergency situation, in a true blue act of eccentricity, the BBC, incredibly, sent its symphony orchestra consisting of nearly 100 members, to play in the proposed tunnel under the baton of the famous Sir Adrian Boult, with a view to checking the acoustics. One can only presume that the BBC wanted to ensure that even if Britain was about to be completely and utterly destroyed, radio listeners should not be denied broadcasted symphony concerts of the highest quality whilst the bombs dropped around them. The maestro reported favourably. Unfortunately the delay incurred in adopting these procedures had upset the BBC's plans. The Director General went in person to inspect the tunnel, but the Nazi Air Force beat him to it and after a series of heavy raids, local people were occupying the tunnel for shelter. The Director General took a typically British view and at once decided that it would be impossible now to occupy the tunnel. The BBC had already considered the use of the Rocks Railway Tunnel but had rejected it due to the anticipated difficulties of coping with the steep incline. Circumstances now dictated that they should construct their alternative base here.

July, 1941. The BBC intended erecting structures in the tunnel which would constitute a breach of covenant. A Clerk to Bristol City Council opened negotiations with all

interested parties with a view to vesting in the Bristol Corporation 999 leasehold title free from all covenants which would prevent the use of a tunnel for other purposes. At this stage the structures which had already been erected in the tunnel by the Ministry of Works constituted a breach of covenant.

The result of negotiations was that the Tramway Co assigned their leasehold interest to the Bristol Corporation free of charge. The Society of Merchant Venturers released their right to enforce the covenants as to keeping the tunnel for railway purposes also free of charge. However, the Society still required that the entrances to the upper and lower stations should be kept in good repair, the Ministry having sole use of the upper entrance for which they were solely liable for keeping in repair. The BBC and Bristol Corporation were jointly liable for the bottom entrance. The Grand Hotel Company who by then held the original lease to Mr Newnes, and who were entitled to the rent of £50 per annum payable by the Tramway Company, were only prepared to sell their interest and release the covenants. Their asking price of £1,500 was met by contributions from the Ministry of Works and Buildings of £800, the BBC £400, and the balance of £300 coming from the City Corporation. The Grand Hotel Company continued to impose covenants covering nuisance, interference or damage to the amenities of the Hotel, and their title to the land at either station.

Upon completion of the transfers to the Bristol Corporation, a lease was granted to the BBC for a period of 21 years at a nominal rent of 1/= for the bottom portion of the tunnel, and part of the bottom station, free from any liability to reinstate the tunnel at the end of the tenancy.

24 February, 1941 Work proceeded on the BBC installation alongside the negotiations.

28 February, 1941 The four carriages were removed from the tunnel, this part of the conversion being subcontracted to the Bristol Tramway Co.

Within three months there had been constructed within the tunnel four large chambers, one above the other, with three smaller chambers being provided at ground level. The total cost of the conversion was about £10,000, of which £6,000 could be attributed to construction work.

Description of the BBC Installation

Top Room: Transmitters

Various transmitters were incorporated in this room. One served Bristol with programmes whilst two others were set up to keep the station in touch with the outside World in an extreme emergency. The largest transmitter was an American RCA 'H' group transmitter operating on 203.5 m and broadcasting the home service. This had been brought over

from America on land lease in the early days of the War. The other two consisted of a Harvey McNamara shortwave set, and an ex RAF medium wave transmitter for restoring communication between the other main provincial and metropolitan broadcasting stations should the Post Office telephone lines be damaged by enemy action.

Second Chamber Down: Studio

This was equipped with piano, gramophone and other facilities for musical, dramatic or school's programmes and could take a cast of 10-15 actors. Poor acoustics were accommodated by installing heavy carpets and providing strategically placed quilting on the walls. Small scale musical, dramatic or feature programmes could be produced in this room

The Third Chamber Down: Recording Room

This room contained a Philips-Miller record and replay machine which used gelatine coated celluloid film 7mm wide, onto which recordings were cut with a sapphire stylus. Also within this room were sufficient programmes for many weeks of broadcasting.

Fourth Chamber Down: Control Room

Here the BBC Engineers surpassed themselves in compressing an enormous amount of equipment into a very small space. The room incorporated switching gear for no fewer than 80 land lines leading to outside stations. The Post Office routed these in various formations to minimise the risk of a single bomb damaging all in one go.

The Three Smaller Rooms at Lower Ground Floor Level

These rooms held emergency diesel generators, a special forced ventilation plant in which full precautions were taken against gas attacks, and a canteen containing sufficient food and water for several weeks.

Exterior

An aerial was strung from the tunnel head to the Grand Spa Hotel. At the lower level station the main entrances and windows were blocked, and ventilation ducts were installed externally.

Throughout the Control Room was manned day and night, transferring countless thousands of programmes in many different languages to various transmitters. However, the emergency studio never had to be used. Just in case, whenever the bombs began to fall on Bristol during the War, key programme staff used to pile into an armoured Dodge Shooting Break car and make a dash to the tunnel where they would stand by to go on the air if required. Thankfully, the

main studios at BBC Bristol were never silenced, but the usefulness of the Control Room alone fully justified the work which had gone into the conversion of the railway tunnel.

After the War

30 July, 1946. The War was over and the BBC had reviewed its transmitter and studio capacity, and was ready to terminate its tenancy and remove all of its equipment, except for the heating lighting and ventilation plant. The ventilation plant had cost £1,600 to install and would cost £104 to remove. The Bristol Corporation were prepared to purchase all this plant for the sum of £5.5.00 in exchange for no claim being made for reinstatement in respect of the premises. Ideas had been mooted to retain the station as a museum piece.

28 August 1946. International trouble arose over the use of the 514 m waveband, and to comply meant reducing power on all main transmitters, and boosting the signal using local transmitters. Thus the Bristol transmitter was retained as a local booster station.

October, 1946. The Ministry of Works' lease was surrendered.

1955. The tunnel was becoming a drain on the BBC's operating costs, the annual rates alone being £549. A new lease was therefore negotiated by the BBC for accommodation in the upper part of the tunnel, incorporating the landing or upper platform at the head of the tunnel, together with a right of access through the entrance on Sion Hill, adjoining the Hotel, and together with the right to place and maintain a 40 foot aerial mast and hut above the premises, the mast to be stayed at three points. The BBC took on this lease for ten years at a rental of £10 per annum exclusive of rates, whilst the original lease for the bottom section was surrendered at the same time.

This turned out to be a timely withdrawal from the bottom section as defects were about to be found at the base of the construction.

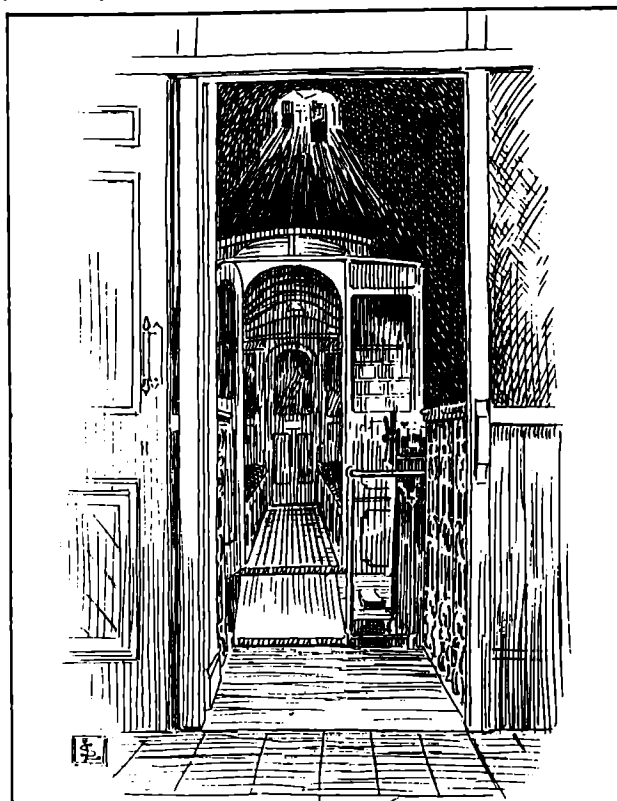
Structural Movement

1956. Cracks were noticed between the masonry of the lower station facade and the face of the limestone cliffs. Further inspection showed that a crack some 4 inches wide had also opened up in the brick lining to the tunnel immediately behind the facade. Tubular steel scaffolding was used to shore up the facade and the slope behind the facade was cleared of loose rock and earth and a total of some 1,000 cubic yards of material was removed. The dense growth of vegetation on the cliff path steps behind the portal was also cleared. The facade of the railway changed in appearance at this stage, with a considerable quantity of the high level side.

masonry being removed.

August, 1957. A W Skempton DSC MICE, and D J Henkel PhD AMICE, eminent Engineers specialising in soil mechanics were employed by the Bristol City Engineer to give advice on the measures that should be taken to ensure the stability of the tunnel facade and the cliffs at this point in the Avon Gorge.

Many of the walls built to retain the earth of the terraces over the Rocks Railway tunnel showed signs of movement. These walls had been constructed before the tunnel had been built and cracks now were particularly marked where walls crossed the line of the tunnel. To obtain information about the site, boreholes were sunk. The boreholes confirmed that a layer of clay about 5 feet thick was sandwiched between



*Fig. 4 THE CLIFTON ROCKS RAILWAY
LIFT. HOTWELL ENTRANCE*

layers of limestone rock, the strata dipping steeply downwards towards the Cumberland Basin. The boreholes would not hold water and it was concluded that the tunnel was acting as a drain removing water which was collecting above the clay layer. A considerable area of the tunnel was very wet.

January, 1958. It was recommended that a series of tied buttresses be constructed along the face of the tunnel in Hotwell Road. These buttresses were constructed from rolled steel sections encased in concrete and the whole assembly was anchored to the cliff using rock inclined anchors connecting

the top of the assembly down into the rock behind. Additionally, a series of drainage boreholes were specified through the clay layer above the tunnel, to be backfilled with gravel to ensure drainage of the upper limestone rock in the area of potential instability.

24 March, 1960. With changes brought about by advances in technology, the radio station became redundant and the BBC's lease determined.

Since 1960. The Pump Room was used from time to time as a store, but except for the passage of telephone cables, no permanent use has yet been found for the tunnel and stations.

Present Status

The top station is in poor condition with the original station layout disturbed by the subsequent modifications which have been introduced. A false roof of fibreboard covered with asphalt has collapsed into the station leaving a skeletal timber framework.

The tunnel itself is wet in places due to seepage, but the majority of the brick lining is in good condition considering its age. The track bed has been almost entirely built over. Two staircases 4 feet 6 inches wide have been constructed against either side rail of the tunnel from top to bottom. Both staircases have treads constructed from precast concrete units. The centre channel between the two staircases is separated from them by solid brick walls. There are also a number of cross walls dividing up the centre channel into compartments. In the upper parts of the tunnel these areas give the impression of steep narrow cinemas with tiered

platforms rising up the slope of the tunnel between the two walls dividing the centre section from the staircases on either side. Further down, the BBC modifications are in poor condition, with most of the timber floors having disintegrated. It is estimated that in excess of 27,000 cubic feet of brick and concrete are now resident inside the tunnel.

The bottom station still contains the BBC's ventilation plant and the configuration of the rooms is virtually as original. However, the arches that once led to the verandah have been bricked up save only for small openings at the top of each arch into which the open ends of the BBC air ducts once fitted. Unfortunately, the stabilisation work necessary to prevent further leaning of the facade towards the Portway has severely disfigured its elegant architecture.

Future Use

Many ideas have been forthcoming on the utilisation of this fascinating relic of yesteryear. In all cases, the costs of providing the necessary conversion work far outweigh the returns. There is perhaps something to commend the idea of leaving it alone so that it can remain virtually unnoticed except by the few who have discovered its charms. It seems that the tunnel is almost certain to remain, in economic terms, what it has always been: an eccentric, exciting white elephant.

Acknowledgements

Thanks to Bristol City Reference Library; University of Bristol Library; Bristol United Press Library; South West News and Picture Agency.



Fig. 5 THE AUTHOR VIEWING THE MAIN SHAFT IN RECENT TIMES Courtesy of South West News

AN EARTH HOUSE AT CRICHTON MAIN, MIDLOTHIAN.

Alfred Grandjean

These are general notes on a visit to an earth house at Crichton Mains, Midlothian (NT 400619) which as far as is known is the most southerly in Scotland. It has some unusual features.

It was discovered by the farmer whose horse stumbled when it's foot went through a hole in the ground. This must have been just prior to 1869 in which year, it seems an excavation to clear the chamber was carried out.

It is not clear what happened on site between then and 1929 when a survey was carried out and the chamber was cleared of debris again and a report was written for the 'Inventory of Monuments of Midlothian'.

The earth house is situated on private land in an arable field and is fenced around. The field is on the south side of a narrow metalled country road just over 0.75 miles from the village of Crichton. It is 50 feet long and, like most, is curved on plan, the concave side is towards the north, and it is on this side a second entrance was made at a later date.

The original construction of this earth house seems to have followed the general pattern wherever they are situated in Scotland. Because the chambers are very near the surface they were certainly made by the 'cut and cover' system where a trench would be excavated and then lined with dry-stone walling consisting, in the most cases, of natural boulders and large stones; very rarely the floor would be paved, but not in this case. The width of the chamber varies between five and six feet and is in the main six and a half feet high, about average for earth houses.

The finished trench would be capped at roof level with large flat flags of irregular shape which span the whole and lay across the top of the walls with infilling of smaller stones where gaps between the gaps of the stones are large. The entire cover is protected with earth or turves and in due course aided its concealment.

It is universal that the entrance will be at one end of the chamber, and in most cases have a short restricted tunnel with steps or an incline down to the chamber. At Crichton Mains the tunnel is longer than most at twelve feet. The puzzle is why this entrance was made when it was known the original entrance existed, for the report of the survey states; *At the N.W. end of the earth house is an opening 2 feet 10 inches in height by 2 feet 8 inches in breadth with a massive lintel and two finely chiselled stones for jambs, there is no backing to this opening which is now filled with earth and stones.'*

What is meant by the term 'No backing to the opening' is not clear, in may make sense if it is taken to mean there was no evidence of an entrance by reason of the blockage, yet an entrance had to be somewhere. Today an inclined bank of earth rising from the floor of the chamber to against this end wall covers the 'entrance' and only a large horizontal stone, most likely the lintel, can be seen. It would be interesting to know the reason for not exploring this entrance, for the construction of the new entrance was no mean task.

Where the tunnel ends at the chamber the right, or northern side jamb projects six inches from the wall to form a check; this device is not uncommon in entrances and is thought to be a defensive measure, though in this case, in 1869 it is questionable. The stone in this instance is immense and forms part of the chamber wall so it could still be in its original place. The other unusual feature of this earth house is the roof. In the beginning it probably had 21 roof slabs covering its entire length, not including the original tunnel of which only seven remain, five at the extreme eastern end and the two near the entrance tunnel. The two spaces remaining are vaulted in a shallow arch, almost flat in parts. The vault is made of small flat stones or flags placed vertically like spokes of a ladies fan - built after the discovery of the earth house. The original slabs were most likely stolen and used elsewhere so smaller stones for a vault were more easily obtained needing only formwork to hold it up during construction.

For what reason all this work was carried out, except as a preservation measure, is hard to imagine and has yet to be explained

Dating the structure is based on its fabric containing some *"...69 squared and dressed Roman stones, distributed throughout the chamber walls, in addition the third roof slab back from the closed end has a carved relief of Pegasus the winged horse which was a symbol of the legion in that area of northern Britain in the second half of the first century ..."*

The legion withdrew in about AD 88 which must give the earth house an approximate not-before date. There was a strong Roman influence in the immediate area where half a mile north of the site is a complex of three Roman encampments dating from the first century totalling nearly 200 acres from which 33,000 men and over 1000 horses were supplied.

An item of much debate has concerned the use of these structures. In later years opinion tends towards storage of food being its main use, with a place of refuge as a last resort. This latter suggestion should perhaps not be discounted too quickly for however unsuitable the structure may be as a sanctuary, *in extremis* any port in a storm seems, in the first instance, better than nothing; though an improvement is absence of body when presence of mind sees it an advantage to run.

References.

1. The Royal Commission on the Ancient and Historical Monuments of Scotland. Report 1929, pages 53 and 54 of Souterrain at Crichton Mains, Midlothian.
2. Major Henry Callender, on whose land the earth house is situated.
3. Local information from Longfaugh Farm on whose tenancy lies the site.

Fig. 1 PLAN

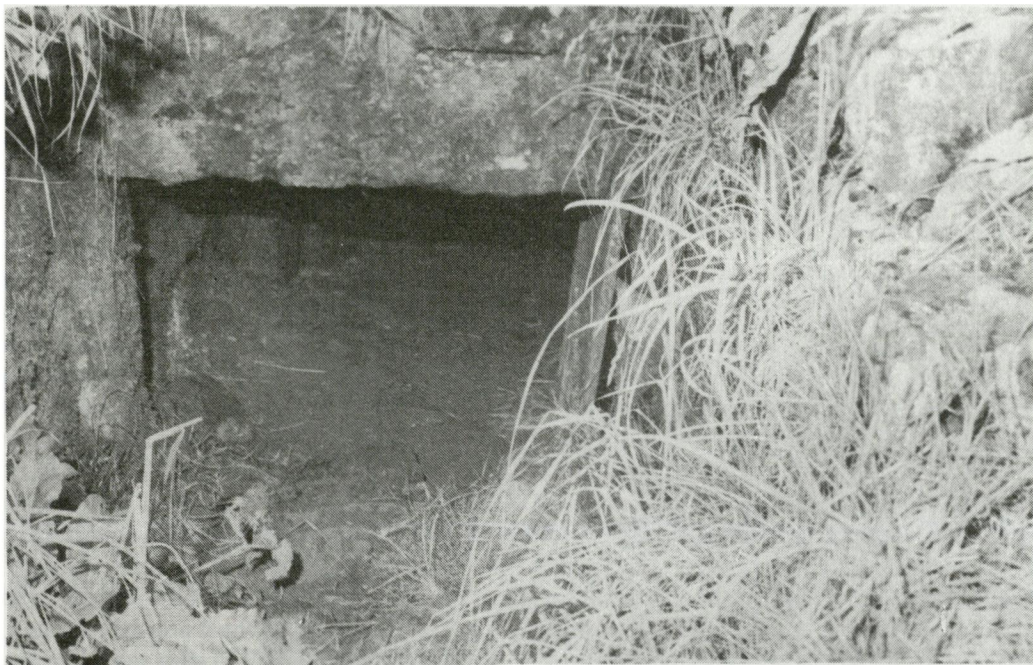
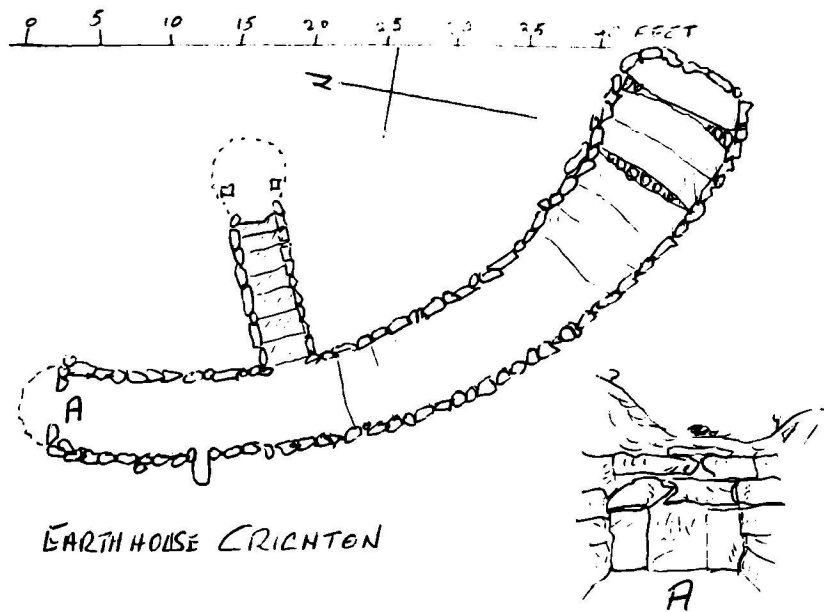


Fig. 2 ENTRANCE TO TUNNEL (27
INCHES HIGH BY 42 INCHES WIDE)

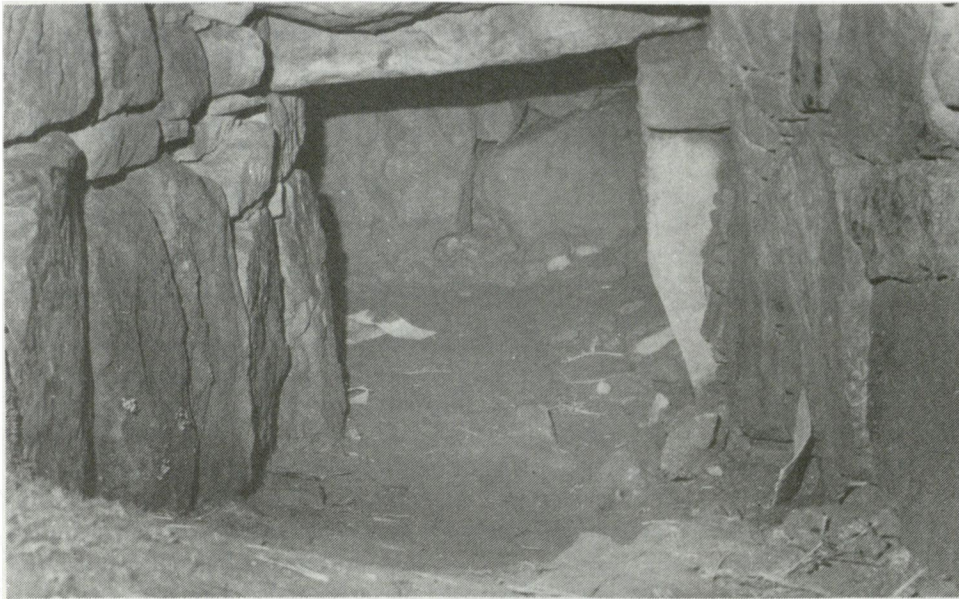


Fig. 3 END OF TUNNEL INTO CHAMBER



Fig. 4 ORIGINAL FLAGSTONES AND LATER VAULTING. TUNNEL ENTRANCE INTO CHAMBER ON THE RIGHT



Fig. 5 LINTEL TO POSSIBLE ORIGINAL ENTRANCE AT TOP OF EARTH BANK



Fig. 1 COPROLITE DIGGINGS IN COW PASTURE ABINGTON PIGOTTS, CAMBS 1883. (Courtesy of Mrs Schlater, Abington Pigotts.)

THE ORIGINS AND DEVELOPMENT OF GREAT BRITAIN'S COPROLITE INDUSTRY.

Bernard O'Connor

About 150 years ago a new extractive industry appeared over parts of Eastern and Southern England. It was agricultural mining - open cast extraction of phosphatic nodules - for use as one of the raw materials in the artificial chemical manure industry. These nodules were known by the trade name of coprolites - from the Greek 'kopros' meaning dung and 'lithos' meaning stone. The deposit was found in both the Upper and Lower Greensand between the overlying chalk marl and the clay beneath. This unique nineteenth century industry remains little known and what follows is a brief description of the workings which dominated parts of Suffolk, Norfolk, Yorkshire, Cambridgeshire, Bedfordshire, Hertfordshire, Buckinghamshire, Hampshire and Kent. It was also found in the same geological strata in France and other parts of Europe.

After the end of the Napoleonic Wars Great Britain entered a period of prosperity with a dramatic population boom. Demand for food increased and the research and development of scientific agriculture began to expand. Traditional manures included soot, dried blood, seaweed,

dried fish, crushed shells, rotted hair, old rags, bones, burnt chalk and lime and of course human and animal manure. Chemical fertilisers were yet to be developed.

Although these so-called "coprolites" had been used in their natural state by farmers on a very small scale since at least 1740 they were "discovered" in 1842 by the professor of Botany at Cambridge University, Revd. John Henslow. On holiday at Felixstowe, on the southeast Suffolk coast, he examined the fossils in the cliffs lying in a seam between the Red Crag and the London Clay. He found some interesting specimens. From their length, size, shape and colour he initially took them to be coprolitic. They were later determined to be the earbones of whales! Aware that agriculturalists at the time had an insatiable demand for manures; shiploads of bones were being brought in from the battlefields of the Crimea and Waterloo. The contents of Sicilian catacombs, mummified carcasses of Egyptian cats and dessicated camel bones found their way into the manure manufacturers' "dens"! Henslow considered the coprolites could similarly be used as manure. When the

results of chemical analysis proved them to have a phosphate content of about 60%, in 1845 he brought them to the attention of the British Association in a lecture at Cambridge. This aroused the interests of the manure manufacturers in the Suffolk and Cambridgeshire area.

One such "gentleman" involved in the trade was John Bennet Lawes. He had been experimenting with phosphates on his estate in Rothamsted, Herts. He ground animal bones, rock and other phosphates and tested them on his crops. However, after dissolving them in sulphuric acid he found the resultant mass, once dried, was super phosphate - a revolutionary artificial chemical fertiliser which was soluble in water. Despite opposition from his mother that gentlemen shouldn't get involved in trade he set up a manufactory at Deptford. He chose the site on a honeymoon cruise on the Thames estuary. Selling what he called "super" at £6 per ton, it was half the price of the most popular fertiliser at that time guano. Since 1838, when shiploads from islands off the South American coast started to be off loaded at Liverpool and other ports, its trade had expanded. By the early 1840s these phosphate-rich bird droppings were being used by agriculturalists across the country with dramatic results. As guano was up to £14 a ton Lawes knew his "super" would be a popular competitor.

It proved very successful on root crops - particularly turnips - as a source of winter fodder, increased turnip yields would revolutionise cattle farming, reducing the need for the annual autumn slaughter. In May 1842 he was the first to patent his "discovery" and was involved in lengthy and expensive court proceedings with chemists and manure manufacturers to defend his lucrative source of royalties. All producers of superphosphate had to pay him £0.25 on every ton they manufactured. This helped finance not only his experiments at reputedly the world's first agricultural research station, but also made him a very wealthy man.

When Lawes and the Ipswich manure manufacturers started purchasing large quantities of the fossils in the early-1840s, a new extractive industry began. They were exposed in the crag pits dotted around the low hills between the Deben and Orwell estuaries and this crag had earlier been used as fertiliser in its rough state. The fossils were also used as a raw material in the manufacture of 'coade' a high quality stoneware used in garden statuary. Landowners were offered as little as £0.40 a ton by companies such as William Colchester and Edward Packard, both of Ipswich, and Joseph Fisons of Thetford.

In Suffolk it was generally the farmer's agricultural labourers who, over the winter months once the harvest was in, would dig out what they called "lizard's muck." Initially, they dug further into the existing crag pits but these were extended as demand for the coprolites increased. In Felixstowe the cliff was dug into causing so much erosion that it had to be shored up with a stone wall in the 1850s. Cartloads were hauled down to the beach or nearest river where they were emptied into huge piles. According to

Walter Tye, who did extensive research with locals who were employed in the industry, the washing

"...was an old man's job when he became too old for the pit. A long tank some thirty feet in length, was specially provided for the job. The coprolites, along with a certain amount of dirt and bones, were shovelled into sieves which, when full, were placed on a ledge in the tank, just under the surface of the water; to each sieve was fastened a long pole, which the washer pulled backwards and forwards until the stones were clean. When there was a shortage of water, in or near the pit, the washing was done at the quayside before loading."

(TYE, WALTER, 1930. 'The Birth of the Fertilizer Industry,' *Fisons Journal*, pp.3-10)

The cleaned fossils were then emptied into wheelbarrows and pushed up wooden planks and tipped into the holds of barges or lighters. These carried the cargo to the wharves at manufactories in London, Ipswich and other ports around the country.

By the end of the 1840s a similar fossil deposit along the eastern and southern edges of the Fens was tested. With a phosphate content of over 60% the entrepreneurial manure manufacturers expanded into Cambridgeshire. William Colchester started operations in Burwell in 1849 and in Cambridge a local chemist, Mr. Deck, offered to pay the owners of Chesterton Brickyard £2 for every ton of what the labourers had previously thought of as "bear's muck." What had been considered "troublesome annoyances" now became a valuable commodity and other brickyard owners and others were quick to catch on to their worth. A veritable "rush" began to extract these fossils and, when the extent of the deposit was realised, land speculation became common. The operations were on a far larger scale than in Suffolk and trenches were sunk across many of the fields in Cambridge. Geological interest in the fossils was intense. One of Henslow's students was Charles Darwin whose evolutionary theories had stimulated huge interest in antediluvian fossils.

Over the following fifty years the coprolite diggings extended along the extent of the Greensand into Bedfordshire by 1862 and Buckinghamshire by 1868. There were cases of an assortment of dinosaur bones being unearthed and used, including plesiosaurus, megalosaurus and iguanodon, also mammoth, elephant, rhinoceros, bear and hyena. The better examples of which were sold to collectors. Occasionally archaeological sites were found. One can imagine what gangs of diggers did on discovering grave goods. Some can be found in local museums but many sites went unrecorded.

Whilst landowners were initially paid similar royalties to those in Suffolk of between £0.40 and £0.50 a ton the practice gradually disappeared. The difficulty of ascertaining the precise number of tons sold before leaving the works was acknowledged by solicitors and land agents. Human nature led to small scale corruption at the weighing sheds. Instead a royalty per acre was paid - providing considerable work for

surveyors and solicitors drawing up strict agreements as to the mode of operations and measuring the acreages worked. The average royalty was about £100 per acre but some coprolite contractors were prepared to pay £200 at the height of the "boom." Nepotism was also common with the friendly tenant being allowed to raise them for as low as £30 an acre. With yields varying considerably they averaged between 300 to 350 tons per acre with the maximum recorded of 1,200 tons! Although manure manufacturers paid £0.40 a ton in the early days prices fluctuated reaching over £3.50. Vast fortunes were made. The value of a small estate could be realised from just one acre. One landowner, the Earl of Hardwick, nicknamed "Champagne Charlie" reportedly made £5000 from coprolite royalties every year! Landowners, farmers, manufacturers, coprolite merchants, contractors, carters, bargees, solicitors and surveyors profited as well as the diggers. Fossil or coprolite labourers' wages were sometimes over £1.00 a week compared to the £0.60 to £0.70 of the agricultural labourers. Many farms lay idle when labourers flocked to the diggings.

Major landowners benefiting from the "coprolite rush" included the Church and Charity Commissioners, eleven of the Cambridge Colleges, an Oxford College, knights, earls and dukes and several M.P.s - even St. George's

Chapel, Windsor. Bankers, merchants and traders similarly profited. In fact, during its heyday the coprolite industry stimulated the local economies of many parishes. Churches, halls and farms were renovated, roads and houses were built, wells dug and many fields were improved by having the soil turned over. However, the quality of workmanship varied. To this day bare patches can be seen where topsoil was not replaced. Long overgrown ponds can be seen where trenches were left unfilled.

The nodules lay at a varying depths. Some were found exposed on the surface which reduced the labour costs considerably. Whilst they averaged between three and four metres deep, the deepest pits were up to thirteen metres. This extra depth often led to reduced royalties. It depended on the avarice of the landowner, farmer or coprolite contractor. It also led to numerous cases of injuries and deaths. A whip round was often the only compensation.

The vicar of Bottisham, Cambs. the Revd. Jenyns, collected considerable data about the workings in his neighbourhood. In a talk to the Bath Field Club he informed his listeners that,

"The deeper the vein the better quality and value of the nodules as there was less labour costs in washing them as there was not as much silt and gravel mixed up with them as when they lie shallower. The work is sometimes done by the day, but more generally by the piece. - A body of forty or fifty labourers will appoint a ganger and an ac-



Fig. 2 COPROLITE DIGGINGS AT ORWELL CAMBS. 1860-70s. (Courtesy of Cambs. Collection)

countant from the cleverest among themselves, and take the work, digging and washing at so much; for fleet digging, as the term is there, or shallow, - (eight to ten or twelve feet below the surface) at 14s. to 18s. per ton; - over that depth (seventeen to twenty feet) - at 20s. to 25s. per ton. Beyond twenty feet the digging is seldom attempted, the market value, now about 30s. to 33s. per ton, not being sufficiently high to remunerate. At one spot, however, near Cambridge, the digging goes down to twenty-two feet, where the nodules are of a very unusual size, being as large as the fist.

The process of getting these nodules is exactly that of "double trenching" on a large scale. The men begin an acre by digging a trench of the requisite depth and barrowing away the material to the furthest extremity of the land, where they mean to finish. After the nodules have been obtained from the bottom of this trench, a second is dug parallel to it, the material from which serves to fill up the first; then a third is dug, the material from this filling up the second; and so on to the end, the last trench being filled up with the material barrowed from the spot where the digging commenced. In each case, the topsoil, after removal, is carefully packed up in ridges, to be replaced at the top of the trenches when filled up again, as agreed upon with the landlords.

The trenches vary in length from thirty to fifty yards. The breadth at the top is ten or twelve feet, but contracted at bottom to four and a half, one side sloping gradually downwards, the other, where the nodules are obtained, being undermined, the refuse material being thrown backwards. This method of working shortens the labour, and allows the trench when done with to be filled up quicker.

Water at places is a great difficulty. The trenches soon get full, steam pumps being employed, and often kept working during the night or early morning, in order to have the trenches ready for the men the next day. Where parties cannot afford steam, hand-pumping has to be done at great cost. Wells in the neighbourhood are observed to ebb and flow in a remarkable manner during these disturbances of the ground; the effect being felt at some distance from the works."

(JENYNS, L. 1886. *On the Phosphatic Nodules obtained in the Eastern Counties, and used in Agriculture. Proc. Bath Field Club*, pp.16)

The scale of some of the Cambridgeshire workings was large. Similar workings took place along the Wey valley between Alton and Farnham in Hampshire from the late-1840s. Details are sketchy but they resulted in the practice of marling being curtailed. Chalk and marl pits on the chalk hills similarly exposed a bed of phosphatic nodules in the greensand which attracted the interest of the geologists, Manwaring Paine and Thomas Way. Their article in the *Journal of the Royal Agricultural Society* revealed how the workings had extended north from Frensham towards Farnham.

'On the opposite or south side of the River Wey, above the new church, in the village of Wrecklesham, there is an outcropping of the gault, below which are some very conspicuous beds of phosphates. At this place a pit has been opened in search of them, or, more correctly, the outcrop on the side of the hill has been worked into. There are three distinct beds of fossils: the first lies above the thin seam of ironstone; it is about three or four feet thick, the fossils being intermingled in a soft matrix of sand and clay. This bed has been wholly carted away, as it was dug to be applied to a neighbouring field of a loose gravelly texture; this was done because the fossils could only be obtained by the tedious process of hand-picking. It may be, perhaps, worthwhile to remark, that this portion had occasionally been carted on the land before, and always with marked benefit. This good result may be partly attributed to the facility with which many of these fossils decompose when exposed to the alterations of weather.

...Another outcrop has been followed out in the commons at a spot distant about half a mile SW from the above pit; but here there is only one bed beneath the iron-sandstone. On digging the fossils the mass is broken to pieces with a pickaxe and passed through a half-inch sieve, just in the same manner as gravel is obtained for road-making. When the fossils become tolerably dry, they are then passed over a finer sieve, which gets rid of the greater part of the loose adhering sand. About twenty tons of clean fossils have been dug from these two sites, at a cost of fifteen shillings a ton. The fossils are easily ground up into powder between cylindrical rollers. The same mill is employed to grind the fossils both of the Upper and Lower Greensand. If a higher percentage of phosphate of lime were required for any particular purpose, it might be raised to about 55 or 60 per cent. by a subsequent process of sieving, which separates the coarser grains of sand from the powder... Some are not larger than hazel nuts, others weigh three or four pounds each."

(MANWARING PAINE, J. and WAY THOMAS J. 1848. *On the Phosphoric Strata of the Chalk Formation Journ. Roy. Agric. Soc.* vol.ix. pp.78-9)

It seems the phosphate content was not high enough to compete commercially with those of Cambridgeshire and Suffolk and they were only used locally. Given the scale of the diggings in Cambridgeshire it was here that major technological developments of the industry took place. Without having the ease of access to water as in Suffolk the diggers had to improvise. A doctor from Burwell whose father had sold some of his fen land to the manure manufacturer, William Colchester, recalled how 'The first thing to do was to throw up a hill in the middle of the ground, and this was done by first erecting a post about ten or twelve feet long, and throwing the (top)soil around it to a height of eleven or twelve feet and of thirty feet in diameter. Three feet from the centre a ring

HORSE-POWERED COPROLITE WASHMILL

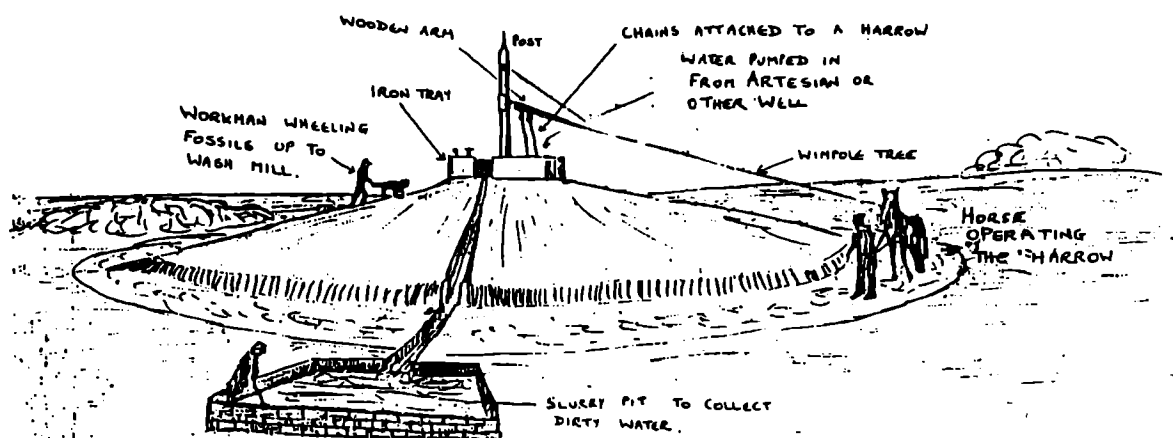


Fig. 3 BASED ON A SKETCH IN R. GROVE
(1976) CAMBRIDGESHIRE COPROLITE
MINING RUSH

would be formed six to eight feet wide and four feet deep. This would be paved with bricks and the sides would be sheets of iron. On one side of the hill a platform was made from a wooden tank, to which was connected a pump eighteen feet long; a pipe from the tank would go with the ring and opposite the tank was a trapped outlet, and on the outer side of the hill a square of about two chains would be earthed up a little to form a sort of pan. From the central post a wooden arm would be attached about twelve to fourteen feet long, to this would be attached a wimpole tree, to which a horse would be yoked. Connected to the centre of the post would be a light rail which was fixed to the horse bridle to keep the horse always in its track; from the arm would be suspended two iron harrows which ran well in on the bottom of the ring. When the soil containing the fossils was wheeled up to the ring a sufficient quantity of water would be let in. As the horse went round a creamy fluid would be produced and the fossils would drop on the floor. Then the trapped outlet would be opened and the creamlike fluid, called 'slurry' would flow into pans. This operation having been repeated a number of times the fossils on the floor would be washed clear of earth and weighed up."

(LUCAS, C. 1931. *The Fenman's World*, p.31)

This was a tiring and time consuming business and the whole mill had to be relocated as the diggings progressed across the fields. This is shown on the composite map of workings in Fig. 4. It shows a field worked for

coprolites in Grantchester, a few kilometres south west of Cambridge. It was made from half yearly surveyor's tracings to determine the acreage worked and thus the royalties to be paid - a more accurate method than weighing thousands of tons at the works. Certainly many kilometres of tramways were laid to take truckloads of fossils to the works as the map of the works in Fen Ditton, a few kilometres northeast of Cambridge, shows. With improvements in the steam engine some coprolite contractors invested in the new technology. In Shillington, Bedfordshire, John Bennet Lawes had an agreement to have the coprolites raised from some fields and his financial backing allowed his manager to use these new methods. An article in the 1871 *Agricultural Gazette* informed the reader that the contractor

"...sinks and bores a well, getting through the gault into a water-bearing stratum. He sets up an 8 or 10-horse power engine in a shed near the well, and thence pumps sufficient - say, 30 or 40 galls. a minute - into a horizontal washing mill, into which and out of which this water continually pours. The mill itself is a circular ring trough, perhaps of nearly 14 feet outer and 9 feet inner radius, thus providing a circular bed less than 5 feet wide and 3 or 4 feet deep, into which, it may be 100 trucks of the dug out coprolite stratum are tilted, one in every five or six minutes, throughout the day. A pair of heavy long tined iron drags within this trough are continually driven round and round, by proper mill gearing, worked by the steam engine, and the muddy water, laden with the clayey matter thus discharged,



23. O. 22 Aug by 10/4/1875

is constantly pouring from it, leaving the hard nodules in the bottom of the trough. After 60 or 70 loads have been thus tilted in, the water is allowed to run clean. Three such washings, each of four tons weight or thereabouts, may be got out in two days. In one field at Shillington, near Hitchin, there were three such mills at work, and 100 tons a-week were being got - about 170 men and boys being at work. The diggings here are very deep, and the costs in this case probably are largely in excess of the average. (The Agricultural Gazette, December 23rd 1871, pp.1657-8)

By the end of the 1870s engineers had developed a more efficient washmill - probably the precursor of the present-day vegetable washer. In Potton, Bedfordshire, Lawes Chemical Manure Company had leased coprolite land from the speaker of the House of Commons, Arthur Peel, M.P. who lived in what is now the headquarters of the R.S.P.B. at Sandy. The Bedfordshire Times of May 1878 reported how "...the coprolites are wheeled in barrows to another portion of the ground, where a cylindrical sieve is fixed for the purpose of freeing them from the adhering sand. This machine, which is worked by horse power, is a round cylinder of sheet iron, perforated with holes of a quarter-inch in diameter and placed horizontally in a tank containing water, the cylinder being half submerged. The drum of the cylinder is two feet in diameter at the larger end, one foot at the smaller, and ten feet in length. The fossils are put in the the larger end, and as the machine revolves, the smallest stones and sand fall through the holes into the water the and the larger are carried along by a screw arrangement and emptied at the smaller end into barrows holding about half a hundredweight. When these are filled they are wheeled by men into the sorting sheds, where the women are engaged in the process of sorting. These sheds, which are 28 feet long by eight feet wide, have on each side a bench separated by partitions, with sufficient room for one woman to work. The fossils being largely mixed with sand stones, it is necessary that they should be removed before they are ready for market. The fossils in their mixed state are emptied on the benches where the women are at work and being there sorted, the stones are thrown on the floor of the shed and the fossils passed through a hole at the back of the benches into a box which is placed outside, and thence wheeled into heaps ready for sale." (Bedfordshire Times May 1878)

Women and girls were only employed in areas particularly sandy as in Sandy, Potton and Everton in Bedfordshire and Wicken in Cambridgeshire. In Wicken numerous gangs of mothers and daughters worked in the sorting sheds. Whilst details of the social and economic impact of the diggings are a fascinating study in itself the following 1866 Parliamentary Report on Child Labour sheds some light on it. William Colchester was the owner of some works in Sandy, Beds. and William Coulson his local manager.

Extract from letter from the Rev. J. B. James, Rector of Gamlingay, to Hon. E. Portman..

"The coprolite diggings in our neighbourhood have occupied very many of our boys, many of whom earn at them 8s. and 9s. a week, which is more than the farmers can give them."

Mr. Coulson. - "Girls of 7 years up to 18 years are employed in the coprolite works. The work is taken by the piece; they get a sum per ton for picking over the fossils. A girl of ten years would earn 7s. a week by day work, but much more by piece work. The state of education among them is very low; some can read, hardly any can write. The parents also are very uneducated. This and the adjoining district of Polton [sic] is a gardening tract; children are much employed in large numbers in peeling onions and such like work. I have seen gross cases of immorality and indecency, even among the smaller children, at leisure moments at the coprolite mills when waiting for the carts, and have heard much bad language, which is readily learnt by the young from constantly hearing it round them. The foremen do not check them. The sexes should be separated at the mills, by means of different sheds, or even by separate mills for boys and girls. In one instance the foreman keeps a public house, where the wages are paid, and the men and children are allowed to have as much drink as they like during the week on credit, and the money is deducted on pay night. These children have no time for learning, except in the evening."

(Parliamentary Papers 1867-8 XVII. 1st Report of the Commissioners on the Employment of Children, Young Persons and others in Agriculture. p 108, 343, 506, 518. Evidence to Mr. Portman and his Summary.)

Evidence has emerged of an assortment of social and economic issues which accompanied the diggings - drunkenness, fighting, overcrowding, rape, theft, inflation, unemployment, strikes and incendiarism but the *Sub Brit. Bulletin* does not have enough pages for such a thesis. The industry does have a link with the Channel Tunnel though. Coprolite mining took place on the same site.

Geological coverage of the Weald referred to diggings in this area as early as 1865 with a suggestion that the seam was exposed in the cliffs near Sandgate, Kent. and also in a railway cutting near Cheriton Church. There were also references to exposures, possibly exploited in a pit near Ford, on the Canterbury Road, and in a road section just east of Stone Farm, Saltwood. (TOPLEY, W. "Geology of the Weald," *Mem.Geol.Surv.* 1875, p 147, 390) It was the autumn of 1870, however, when the first evidence of their exploitation on any scale emerged. The local paper reported

"A SPECULATION. - During the past week much curiosity has been excited in this town and neighbourhood at the sight of between thirty and forty men in a field adjoining Sandgate and Shorncliffe Railway Station, digging

Fig. 5 CYLINDER WASHMILL (SKETCH)

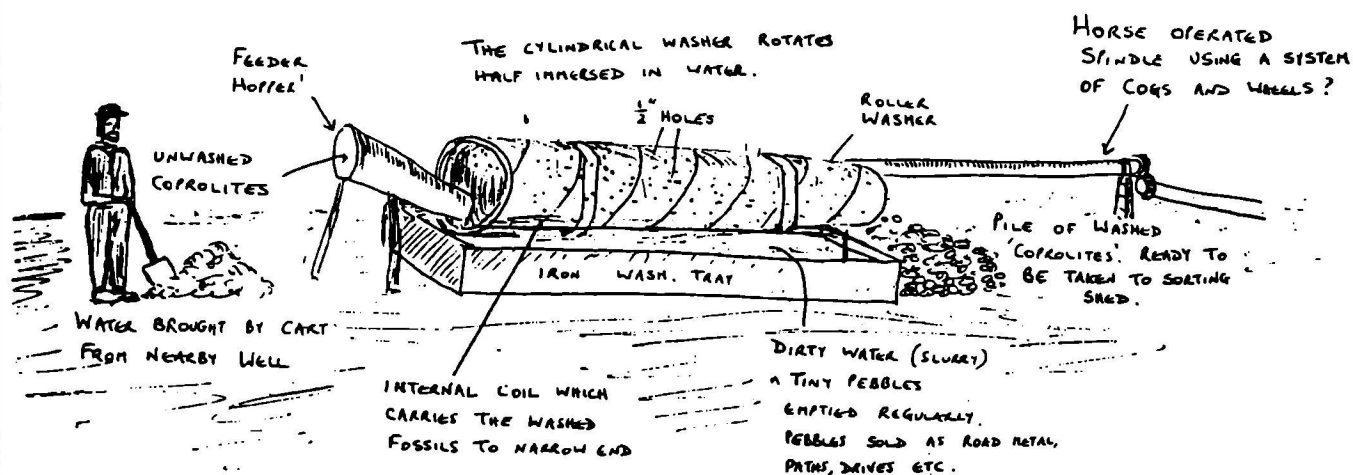


Fig. 6 CYLINDER WASHMILL AND FOSSIL SHEDS ON SANDY HEATH, BED c. 1883 (COURTESY OF POTTON HISTORY SOCIETY)



and sifting the soil. Various rumours have been afloat in reference to the object of this excavating process, and many credulous people have reputed that a gold mine has been sprung in the neighbourhood. Such a statement, and the report of the work going on at this place, has drawn a large number of people to inspect the ground, and who have tried to discover, what seems like one of the wonders of Folkestone. The men at work have been forbidden to impart any information, and this has increased the curiosity of spectators. The facts, we believe, are these. Some speculators have undertaken this work, and they are the pioneers, for this part of the country, of a new branch of industry, yclept (sic) coprolite digging. The great resemblance between the geographical character of this part of the country, to that of other places where these lucrative diggings flourish, induced one or two speculators to test the soil for this valuable production, the result of which is so far satisfactory. For the benefit of the uninitiated (sic), it may be observed that coprolite is generally supposed to be the fossil excreta of an extinct race of animals, (although some learned men say otherwise.) After being operated upon by vitriol, or other powerful acids, it forms the most potent and valuable manure. We hope success will attend the efforts of those who are trying to discover such a valuable produce beneath our soil. (Folkestone Chronicle 29th October 1870)

The article must have stimulated considerable interest and the following week a further mention was made of the work.

“COPROLITE. - The search after this valuable remains of a bygone period, which has been going on near the Shorncliffe Station during this past week, is now brought to a conclusion. A large quantity of coprolite has been discovered, and the excavations have extended ten feet below the surface. Further down than this, in the part of the land where the digging has been confined, this substance does not extend, and the vein appears to terminate, and is succeeded by a strata of another substance. The probability is, however, that there is a considerable deposit in the neighbourhood, but whether sufficient to undertake erecting manure works here is another question. There can be no doubt the land presented a promising aspect, or the speculator would not have gone to the considerable expense he has done in making discoveries. The large pit, or trench, which has been dug, is now filled in, and yesterday boys and men were engaged in sifting, and sorting the coprolite which will be carted away to the railway station, and sent to a destination for the purpose of chemical analysis. Many tons have been set apart for this purpose, with what result time only will reveal.”

(Folkestone Chronicle 5th November 1870)

Research shows that the London-based Lawes Manure Company were involved but other manure manufacturers may well have operated other workings in the area. They only

lasted for two years as evidenced by a diary report of George Beaver, a surveyor employed by Lawes to measure the extent of the workings.

‘On the evening of Wednesday 23rd of October 1872 I go with Mr. Weston to Folkestone, to make survey of some lands in the parish of Cheriton, for coprolite workings, on Estate belonging to Frederick Brockman Esq. and get home to Hitchin again very late Friday night. These works do not continue long time in operation, as the (material when dug (tho’ promising to appearance) on tests turns out to be but poor and the works are soon closed.’ (Hitchin Museum, Diaries of George Beaver, 98b.)

As far as underground mining was concerned, however, there was very little evidence. The only cases being at Bassingbourn, in Cambridgeshire and on the North Yorkshire coast at Speeton. In early spring 1866 the Cambridge Chronicle reported how a new system of works

“...has just been introduced into this county for the recovery of fossils or coprolites from the deep beds of the earth by Mr. C. Cooper of Bassingbourn. The principle is that used in mining operations, a shaft being sunk to considerable depth, and headings formed to run diagonally to the main shaft by tramways so that an immense amount of labour is saved by bringing the stone up by steam power. The engines are fitted by Mr. Cooper on the most modern and approved plans, and are well adapted for the purpose.

(Cambridge Chronicle 10th February, 1866 p.5.)

How long this method was continued for is unknown but the high water table in the area must have incurred high pumping costs. Over a decade later, in an 1881 article on the geology of Cambridgeshire, two geologists, Pennings and Jukes-Browne, pointed out that

“Attempts have been made to get out the mineral without removal of the overlying marl, by driving tunnels along the bed, in fact by the methods similar to those adopted in mining, but the base of the marl follows the general rule of dipping in under the higher ground, so that the water within it, held up by the gault beneath, has hitherto presented an insuperable difficulty to this plan, but we are inclined to think that by collecting and working out a sufficient number of data, spots might be found where tunneling for coprolites could be carried on at a cheaper rate than 25 feet of overlying earth can be removed”.

(PENNINGS and JUKES-BROWNE, ‘Geology of the Neighbourhood of Cambridge’ Mern-Geol. Survey 1881, p.126)

In fact the tunnel was recently uncovered during the laying of a gas pipeline. A metre below the surface it ran in a dogleg about a metre wide and two metres high with, unusually, a gabled roof. Deep water precluded further investigation. (Conversation with Sylvia Beamon, Royston, Herts.)

The workings in the cliffs at Speeton were in operation by 1868. Septaria, large nodules of stone washed out from the cliffs were collected from the beach and off shore and transported by coasting vessels for use in the cement industry. The coprolites lay below these stones and above the clay in the Neocomian beds. Here they were excavated from the cliff face, just east of Rancliff Ing, three quarters of a mile North of the village. (1 inch Geol. 1st Ed. XCV SE Scarborough 1881)

"...timbered adits are driven into the cliff at points below the outcrop of the cement bed. (Where they meet the bed) galleries are driven in every direction in the bed itself, the material and refuse being carried out in small wagons running on tramways which are laid down in the adits. The stone is usually conveyed by train to Hull by railway." (JUDD, J. Proc. Geol. Soc. v. 1868 p. 250)

The paper, dated 22nd January 1868, went on to describe how another bed of coprolites was exploited when a seam was exposed after a landslide.

"The 'Coprolite bed' at Speeton was first discovered on the shore when the sand and shingle had been removed by a storm, and afterwards traced up into the cliff. It is now worked by adits but, as it only averages 5 inches in thickness, this expensive mode of working is found to be scarcely remunerative and is likely to be soon abandoned. About 500 tons of 'coprolites' are annually exported from Speeton Cliffs. They consist of very dark-coloured almost black stone, containing much pyrites, and mingled with worn casts of shells. Samples tolerably free of the investing clay yield from 57-61% of phosphates." (Ibid.)

Further south in Norfolk a valuable bed of coprolites was found in 1873 in the parish of West Dereham. However, it was a newspaper report the following year, 1874, that shed most light on the workings.

"DISCOVERY OF COPROLITES IN WEST NORFOLK - Mr. Peter Bunn, ironmonger of Long Stratton, an amateur geologist, has lately made a very important discovery of a bed of coprolites between West Dereham and Downham. There are immense quantities in the clay of the district and the quantity is said to be equal to those in Cambs. Sir William Bagge, Hugh Aylmer, Esq. and H.B.B. Mason, Esq. are proprietors where the bed of coprolites have been found in this county. They are willing to give Mr. Bunn encouragement to utilise his discovery, and he has already established works at West Dereham, where he is working 100 acres and where he has obtained large quantities of coprolites. He is now employing several men, who will soon be increased in number when the machinery requisite is on the spot. This new branch of industry is likely to benefit the neighbourhood. Specimens of coprolites will be exhibited at the show of the Norfolk Society at Norwich. Mr. Bunn believes that coal may be found in Norfolk." (Norfolk Mercury 23rd May 1874)

Two other companies were very much involved in the parish, both coprolite raisers and manure manufacturers. These were Thomas Thwaites Ball and Co. of Burwell and James Fison and Son, who had branches in Thetford, East Dereham and King's Lynn. (*Kelly's Post Office Directory, 1879*)

Sale particulars and solicitors records from across the coprolite belt shed further light on how the technology improved over the fifty or so years the industry was in operation. The earliest evidence was in 1862 when a distress of rent led to proceedings against a contractor in Ashwell, Herts. Solicitors' papers revealed him having two horses and harness, a quantity of coprolite, weighing machine, wheelbarrows and planks.

A 1870 sale in Bassingbourn, Cambridgeshire, reveals just how much more sophisticated the engineering was. Almost twenty years later there were still greater improvements as evidenced by the following particulars. The president of the Superphosphate Manufacturers Association, Sir John Morris, had finished a licence to raise the fossils at Great Brickhill, Bucks, and ordered his manager, Henry Wilkerson, to have it auctioned.

COMPLETION OF CONTRACT

GREAT BRICKHILL & WATER EATON

About One-and-a-half Miles from Bletchley and Fenny Stratford.

.....
To Engineers, Contractors, Builders, Farmers, and Others.
MESSRS. CUMBERLAND HOPKINS
Have received instructions from Mr. H. Wilkerson
TO SELL BY AUCTION
IN NOVEMBER

THE PLANT

Which has been in use at the Coprolite Works on the Great Brickhill Estate CONSISTING of a 6-horse portable steam engine, by Marshall, in good working order; a centrifugal pump, by Gwyne, with indiarubber hose, a force pump, a 22-feet iron water wheel, a nearly-new stone washing cylinder, with tank, a weigh-bridge by Avery, a quantity of 4-inch piping, about 4,000 sleepers, about two miles of iron rails (16lb. and 40lb. to a yard), six tip wagons, a windlass, with frame, double brakes, and about 400 yards of wire rope, a quantity of wheelbarrows, planks, leather straps, etc. also the PORTABLE BUILDINGS, comprising three work-shops, three stables, a harness room two offices, engine shed and two others, and post and rail fencing.

This valuable plant is being sold in consequence of the completion of the contract, and it will be moved to convenient places for the purpose of sale.

May be viewed at any time, on application to the Foreman, and Catalogue had at the usual Inns, and of the Auctioneers, High Street, Leighton Buzzard. "
(N. Bucks Times & County Observer, Nov, 3rd 1888)

Although foreign supplies of rock phosphates from Charleston, South Carolina had started to flood the market by the end of the 1870s the coprolite industry managed to survive until the turn of the century. This was primarily to serve those inland manure manufacturers who would otherwise have had high transport costs bringing in the foreign raw materials. The Farmers Manure Company of Royston, Herts. was one such company. Its managing director, Joseph Nunn, farmed land at Bassingbourn which conveniently supplied the company with coprolites until his death in 1894.

Although there are records of workings as late as 1904 prices had dropped to below £1.00 making it unprofitable with high-grade foreign phosphates readily available.

Interestingly, the industry was revived during the First World War when these same supplies of rock phosphates were under attack by the German navy. A large scale operation got under way at Grantchester and Trumpington, just south of Cambridge.

Today there is little evidence of this unique industry which brought temporary prosperity to many parishes on the coprolite belt. As an industry it has gone largely unrecorded in the books on the subject and hopefully this article will have helped stimulate an interest in it.

The author has detailed accounts of the industry in every parish where it was worked and hopes to find a publisher to ensure his research finds a wider audience than the Bulletin's specialist readers.

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BASSINGBOURN,

CAMBS.

A CATALOGUE OF
AN IMPORTANT SALE OF
SECOND-HAND
COPROLITE PLANT
AND
FARM MACHINERY,
INCLUDING
4 PORTABLE STEAM ENGINES,
2 Vertical Boilers with Hoisting Engines, 2 Threshing Drums
& Horse-power Threshing Machine, Roping Machine,
Weighing Machine, Double-action Hand Pump, 2 Water Carts, Screening
Machines, Turn Tables, Water Tank, a large quantity of Wheels, Pulleys and
useful Iron; Posts and Timber, and various Effects;
WHICH

MESSRS. NASH & SON

Are instructed by W. P. Colchester, Esq., to hold
On Thursday, the 23rd of June, 1870,
At 12 for 1 o'clock,
At his Factory in the High Street.

May be Viewed the day prior to and on Morning of Sale.

Catalogues may be had on the Premises; and of the Auctioneers, at Royston.

ROYSTON PRESS: JOHN WARREN.

Fig. 7 ADVERTISEMENT FOR A SALE OF COPROLITE PLANT AND FARM MACHINERY. (NOT TO SCALE) (COURTESY OF CAMBRIDGESHIRE COUNTY RECORD OFFICE)

BATS UNDERGROUND

Patty Briggs

Les Chauve-souris sous terre

Beaucoup des chauve-souris hibernent dans les endroits sous-terre. Ils se multiplient, s'accouplent et se perchent de nuit pendant l'été.

Les endroits sous-terre sont très importants là où il n'y a pas de grotte naturelle. Les menaces pour les chauve-souris dans les endroits sous-terre sont la destruction et la tapage excessive.

Les cinq genres de la préservation des chauve-souris sont:

1. La préservation des endroits sous-terre.
2. La protection des endroits sous-terre.
3. L'aménagement des endroits sous-terre.
4. Le changement d'usage pour des endroits sous-terre.
5. La construction des endroits sous-terre nouveaux.

On a aménagé certains endroits sous-terre; on en a construit d'autres' mais avec du succès limité. Nous commençons le rassemblement d'une banque de données partout dans le Royaume-Uni. Nous pourrions évaluer l'importance des endroits particuliers dans un contexte national.

C'est un travail très énorme dans certaines régions. Nous avons produit un code de préservation après avoir consulté plusieurs organisations, Subterranea Britannica inclus. "Bats Underground - A Conservation Code", (Les chauve-souris sous-terre - Un Code de Préservation) encourage des organisations de spéléologie, de l'histoire minière, et d'autres intérêts, de respecter des chauve-souris, et de fournir les informations.

L'organisation "Bat conservation Trust" rassemble les données de mesures de la préservation et l'aménagement des endroits sous-terre pour les chauve-souris. L'organisation "English Heritage" rassemble une liste des endroits plus importants.

Underground sites are extremely important for the survival of many of our British bats.

The main use of underground sites by bats is for hibernation in the winter months. Some sites are used for breeding, mating and night roosts in the summer. The degree to which different species rely on such sites varies. Some will use caves all year round. Natural caves would be used by bats if available. The horseshoe bats depend on such sites. They will use these sites for hibernation. Some of you may have been lucky enough to see these bats which are easily identified from the way in which they fold their wings around their bodies. They will also use underground sites for breeding, seeking out dome-shaped hollows in the roof of caves where warm air gets trapped.

Other species found underground in this country are natterers, daubentons, whiskered, bechstein - rarely and used to include mouse-eared but not any more and brown long-eared often tucked into crevices.

Night roosts can often be identified by finding piles of moth wings.

The use by bats of these natural sites is of a primary nature. However, a secondary use of man-made underground struc-

tures is by bats. They have taken to using such sites in areas where natural caves are scarce. In many places, these sites are an important alternative to caves. A quick look at the underground sites used by bats in London shows that all underground sites could potentially be used by bats. These include ice-houses, tunnels air-raid shelters, lime-kilns, forts, gunpowder mills, filter beds, tunnels under reservoirs and grottoes. 20 out of 31 ice-houses surveyed in Hertfordshire have been found to be used by bats.

The conservation of underground sites falls into five main categories.

1. PRESERVATION. The main threat to bats is loss of these underground sites. South Mymms chalk mine, Herts, was in danger of being lost to bats through dumping of rubbish on a grand scale down the only open shaft. The owner had to be persuaded that this was not in the bats' best interest. The mine has since been improved for bats by opening up two other shafts. One shaft has been constructed in a such a way as to prevent the easy dumping of rubbish in the future. Opening all three shafts has improved the

microclimate and hopefully will encourage more bats to use the site.

Hatfield denehole, like many other similar sites, was filled in after the war because of the fear of children falling down the shaft. These shafts can be cleared and opened up for bats but is not a task to be taken on lightly. From being just a shallow depression, there is no knowing how far your hole will take you!

Electric hoists have to be begged, borrowed or sponsored, as was this one was, by Advanced Underpinning of Watford who came to quote for underpinning my house and ended up sponsoring the Herts & Middx Bat Group. Shoring of the top 15 feet had to be done to meet Health & Safety requirements. The shaft is now 32 feet deep with a diameter of 25 feet. Chemical drums can be a hazard making some sites dangerous not only bats but to people as well. One ice-house in the north of Hertfordshire had been filled with such drums which had to be removed because of the danger of toxic chemicals getting into the water table through seepage. Clearance work had to be abandoned after only two hours work because of the danger from toxic fumes which started to build up with the seepage of unknown chemicals from corroded cans and the mixing of these gases due to air movement. The site had to eventually be cleared by people wearing full breathing apparatus. Other sites are saved from loss by building supportive grilles which halt the eventual collapse of the mouth of caves and mines.

2. PROTECTION. Bats, their roosts and access to their roosts have all been protected in this country since 1981 when The Wildlife & Countryside Act came onto the statute books.

Batworkers themselves are strictly controlled in the amount of survey work carried out in hibernation sites because of the danger of disturbance to the bats. Bats only have enough stored brown fat to cope with 4-5 arousals during the winter months. It is therefore important that hibernating bats are not put under any additional strain. Batworkers will only visit these underground sites once a month during the winter.

A voluntary conservation code has been discussed with all the relevant bodies.

Another means of protection is afforded to these sites by grilling. It is expensive but sometimes it is the only way of preventing mindless vandalism. At this one in Suffolk, vandals went in and shot 150 hibernating bats with an air-rifle. Bearing in mind that bats have only one baby a year, if that, it is virtually impossible for those bats to ever rebuild their numbers. The lighting of bonfires in the mine was also a problem.

Sometimes, the grille entrance can be moved so that it is less obvious from a footpath. The entrance to this lime kiln was also turned round on itself to face away from the path.

Classifying a site as an SSSI or a LNR affords a certain amount of protection. This does not, however, protect all sites. Greywell tunnel, a disused canal tunnel on the Basingstoke Canal is an SSSI because of the bats. There was a roof collapse in 1932, creating a wonderful humid 'cave' - ideal for hibernating bats but is in danger of being lost as this

country's best underground site for natterers bats and daubentons if the Canal Society are allowed to open up the tunnel which will give them access to approximately another 1/4 mile before they will have to turn their boats and return. The canal goes nowhere. It seems that rights of way may well have priority over an SSSI!. The lobby that feels that restoration of the tunnel for it's intended use is paramount is very strong

3. IMPROVEMENT Underground sites can often be improved for bats in many different ways. Westerham mine, Kent, is such an example where until the site was grilled, there had been threats of closure of the site. The blocked secondary entrances have been cleared and grilled in 1981. Since then, the numbers of bats have started to increase. This encouraged more improvements and in 1983, a larger entrance was hand dug and grilled with an immediate increase in the numbers of bats. In 1984, two large entrances were machine dug to restore the original entrance size. Since then, open days have been held each summer. Visitors are taken into part of the system and exposed to the full rigours of bat PR. This has proved invaluable in improving bat awareness as well as making money.

Icehouses are easy places to improve for bats without incurring much expense. Clearance of the entrance passages and the icewells replacing solid doors with something that will allow the bats access, from a simple version, to a more up-market version which includes a 6" x 9" bat-sized letterboxes. Providing additional roost space by inserting hibernation boxes but planks suspended against the walls works even better. Lime kilns are usually excellent places for bats and can be improved in the same sort of way. Clay bat bricks can easily be incorporated into repair works especially in the roof of such places. These bricks can be built into all sorts of underground sites - air-raid shelters, etc. Different types of grilles have been tried but grilles don't always have to be used there are other ways.

4. USE ADJUSTMENT AND TIME SHARING. Caves, mines and other underground structures are being graded according to their importance for bats. This grading takes into account not only the number and species of bats involved but also the physical nature of the site and the pattern of usage by the bats. Compared with other European countries, numbers of bats recorded in British sites are small with fewer than 20 known sites with more than 100 bats. Grading gives an indication of where limits on human access would help bat conservation. The bat conservation organisations, working with NCA and NAMHO have been discussing the grading of sites.

GRADE 1 sites will have strict access control throughout the year. Access will be restricted to *bona fide* organisations visiting normally during spring or autumn. This would apply to fewer than 10 sites nationally.

GRADE 2 contains 2 groups of sites where access would normally be in the summer. Grade 2a is sites already gated or grilled and where there is unrestricted access during the

winter. Grade 2b are sites without protection but where there is a strong request that winter visits be avoided.

GRADE 3 sites have no formal access control but visitors would be expected be aware that bats use the site and to behave accordingly; to avoid winter visits if practical and to report any bats seen.

GRADE 4 sites are not known to have any special bat interest and there therefore no recommendation except that visits should follow conservation codes and report any bats seen. The provisional grading of sites in Kent, Sussex and Surrey illustrates the low number of sites where access is strictly limited by the Grade 1 coding. We are not talking about denying access to hundreds of sites. An example of this is Hangmans Wood in Essex where recent restrictions on visiting during the winter has lead to an increase in the number of bats to the extent that the latest count of 70 bats has brought the site up to SSSI status.

New fencing is soon to be erected further back from the original to stop people from dumping rubbish down the shaft. Reducing the numbers of visitors in the winter to such sites as Scott's Grotto in Ware, Herts, allows the bats to continue using the site.

When the new porch was added to the grotto, advice was sought from English Nature as how best to do the work without disturbing the bats. Access for the bats was maintained by leaving out the glass from above the front door and out of two other windows. Hibernating Daubenton bats are usually found tucked away behind the flints and the shell work.

5. CONSTRUCTION This is an expensive way of helping bat conservation. Knowledge gained from the small number of man-made structures though should, in the long term, go a small way in helping our declining bats. So if you happen to come across a few concrete rings lying idle or you happen to know an interested landowner...

preferably a rich one, it is a simple matter the hiring the biggest crane you can find to dig a small hole, well - maybe a bit bigger one, bury the rings along with a few concrete sleepers that you just happen to talk someone into giving you free, the rougher, the better (to provide numerous crevices for roosting- small, roughly built internal brick walls have been incorporated into some tunnels); the owner then landscapes the top, creating an amphitheatre at the side and a large pond at the front to attract feeding bats, rock faces the front to make it look more natural and plants 15,000 trees.

BATS NEED A FEW MORE FRIENDS LIKE THIS LAND-OWNER



THE BAT CODE

DO NOT HANDLE BATS. Also beware of dislodging bats from their roosting position particularly when you are moving through low passages.

DO NOT PHOTOGRAPH ROOSTING BATS. Flashguns can be very disturbing.

DO NOT WARM UP HIBERNATING BATS. This can arouse them. Try not to linger in confined spaces as even your body heat is sufficient to cause arousal.

DO NOT SHINE BRIGHT LIGHTS ON BATS. Both the light and the heat can trigger arousal.

DO NOT USE CARBIDE LAMPS IN BAT ROOSTS. Carbide lamps are particularly undesirable because of the heat and fumes.

DO NOT SMOKE OR MAKE EXCESSIVE NOISE UNDERGROUND. Any strong stimulus can arouse bats.

DO NOT TAKE LARGE PARTIES INTO BAT ROOSTS IN winter. Rescue practices should also be avoided when bats are present.

DO SEEK ADVICE BEFORE BLASTING OR DIGGING. Explosives can cause problems both from the blast itself and from the subsequent fumes. In known bat sites, blasting should be limited to the summer or to areas not known to be used by bats. Digging operations may alter the microclimate of bat roosts

Transcript of paper read at the Subterranea Britannica International Conference, at Bath August 7- 11th 1992

OPERATION MOLCH IN THE VALLEY OF THE RIVER GEUL IN THE NETHERLANDS

Jacquo Silvertant

Les usines de guerre Allemande dans la vallée de la Geul pendant la guerre 1939-1945

Pendant l'année 1944, les nations alliées ont augmentées le bombardement aérien sur l'empire Allemand, pour détruire l'industrie Allemande, et pour terminer la guerre. L'Allemagne, pourtant, a fait de contre mesure - le déplacement des industries essentielles ailleurs dans le 'Reich'.

Pendant le printemps de l'année 1944, 'Organisation Todt', par ordre de Berlin, avait commence la preparation de la transformation des carrières sous terre de la vallée de la Geul en usines.

On a donné au programme le nom 'Sonderbauprogramm'. Quand le bombardement aérien a fait plus de pression sur l'industrie Allemande, le programme est devenu plus urgent. À la fin de juillet 1944, on a commencé les mesures, mais avant la fin de la transformation, les nations alliées ont libérées la region.

In 1986 fieldwork was started to investigate the history of the WWII structures left by German military activities at Heidegroeve near Valkenburg and the Bronsdaelgroeve near Geulhem. Since then as much data as possible has been collected on the German activities in the underground limestone quarries. But it was not until 1990 that the crucial information which allowed the results of the study to take shape was found. This information made it possible to reconstruct the planned and nearly completed, industries in the valley of the river Geul. In the description below reference is mainly to Heidegroeve and Bronsdaelgroeve quarries. This is simply because these two quarries are representative of the German plan for the quarries, and the near completion of these plans on the eve of the allied liberation. Naturally our studies using several Dutch, foreign and private archives, merely give an impression, but still allow us to form a reliable picture of the beginning, growth and execution of the German plans. As well as these documentary studies, field investigations were used to confirm the establishment of industries in some of the underground quarries mentioned in

the archives.

In the course of 1944, when the bombing of Germany was intensified to stop the activities of the German war industry and end the war sooner, Germany made a countermove by shifting its vital industries and accommodating them elsewhere, in areas free from bombing.

In the spring of that year, Organisation Todt began. It was responsible for the building and reinforcing of the European coastal defence system, the 'Atlantikwall'. It started with the construction of the first underground work stations in the valley of the river Geul and in Valkenburg, on orders from Berlin. Later, the German authorities wanted to use the underground network in St. Pietersberg near Maastricht for this purpose as well. In the beginning, the project received the status of a special building programme [Sonderbauprogramm] and, as the pressure of the allied bombings increased, the project became more important. In order for the organisation to progress smoothly, some kind of co-ordinating body was necessary. This body was established by Berlin, but the work was arranged and controlled on site. For that reason an order of Seyss-Inquart was published in

Fig. 1 PLAN OF THE AREA OF THE GEUL RIVER, THE NETHERLANDS.

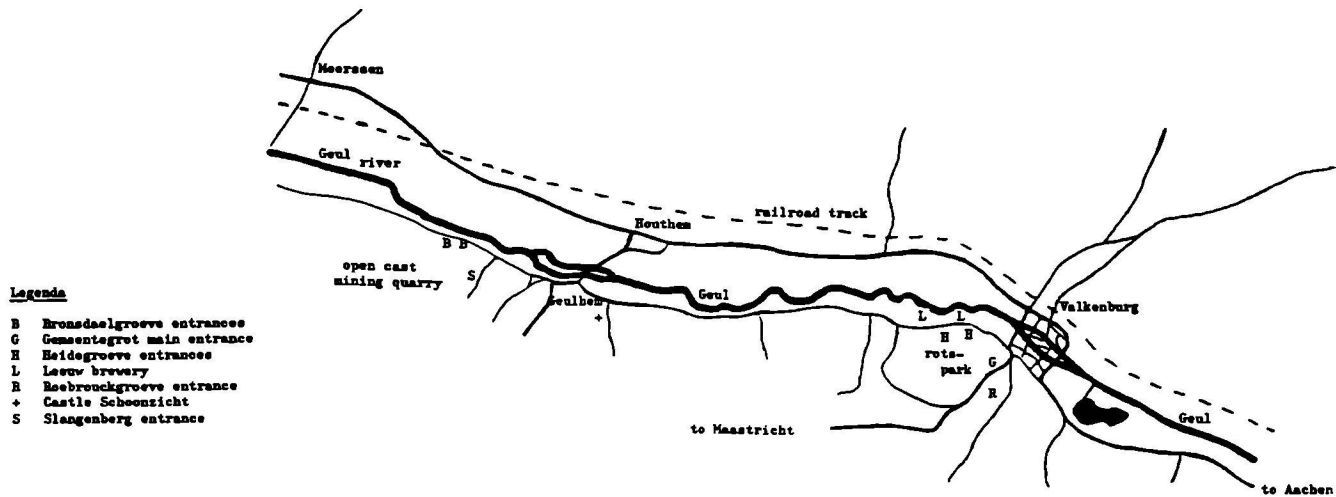


Fig. 2 HEIDEGROEVE - THE MAIN SHAFT BUNKER ON TOP OF THE ROTSPARK 1886-7. Photo by the author.

which, 'zur Förderung industrieller Siedlung', a 'Stiftung für industrielle Siedlung' was founded June 16th, 1944. A 'Bevollmächtigter für industrielle Umsiedlung' was in charge of this. The office of the foundation was settled in the Prins Bisschopssingel in Maastricht. The offices of the construction and organising agencies were settled there as well.

At the end of July, 1944, the administrative machinery started to function optimally. To satisfy the need for workmen, a raid was planned on the Noordoostpolder; the so-called 'Duwelaktion'. This action demonstrated the high priority given to the project. In the Noordoostpolder 1500 people, who were to work as convicts in the underground series of caverns, were arrested. Also, concentration camp workers and workers from the construction industry and technical companies, which participated in the project, were used. The convicts were accommodated in barracks near the quarries. The rest of the staff stayed in hotels or in confiscated houses.

In the end none of the projects were completed. The Germans had to flee from the advancing allied forces before their projects had been realised. The occupier went but his constructions remained. Constructions built 'to last a thousand years' became overgrown ruins and unstable concrete buildings - a typical example of something that slowly becomes part of a period in time which nobody experienced consciously.

Witnesses of WW II will disappear in the transition period towards the second millennium. As long as they are there, we will have their testimonies which often are the basis from which to start a study. These testimonies will never be more than just anecdotes. When at a later stage, sources from archives begin to play a part in the studies, it becomes apparent that the facts often are often obscure and that the testimonies are solely based on vague memories. Memories can be recited when asked for but, consciously or not, can be furnished with a romantic flavour. This situation is typified by the quarries in the valley of the river Geul. Legends became to be associated with Heidegroeve and Bronsdaelgroeve. Concrete factory buildings can be seen and stories are told about these factories manufacturing the terrible and notorious V-weapons, which were thought to be Germany's last chance of victory.

SONDERBAUPROGRAMM [Special building programme.]

VALKENBURG

In the archives each of the projects was given a code name. The complete military works and preparation of the area of the quarries in southern Limburg took place under the pseudonym 'Operation Molch'. 'Molch' means salamander.

BRONSDAELGROEVE (CODE NAME: VALERIE 15)

At first, the installation, which was actually founded in the Bronsdaelgroeve in mid-1944, was planned for the

Roothergroeve near Margraten. An investment application form proves this. From a similar application form, from August of that year, we gather that the company had been moved to the Bronsdaelgroeve. Fieldwork proves that the company had actually settled there and in fact the quarry was adapted to accommodating a factory early in the year. Buildings in and around the quarry can still be seen and show that the buildings were nearly completed in September 1944, except for some finishing touches.

On the basis of the investment proposal, a reconstruction can be made of the German plans for adapting the Bronsdaelgroeve as a war factory. The proposal was made by the Frontreparaturbetrieb GL Utrecht and was directed to the Reichsluftfahrtminister and also the commander-in-chief of the Luftwaffe in Berlin. From this proposal the complete organisation of the project can be worked out from the orders for materials and financial budgets. The construction of the buildings and the organisation was estimated at 1.408,632 Reichmark.

The builders aimed to complete the project by September 15th 1944, in fact, production at a capacity of 10% started in August. Full production should have been reached by October or November but it never got that far.

The plan was to repair two hundred to two hundred and fifty BMW 801 engines, mainly for use in bombers, every month for re-use at the front. Outside the quarry, in a hollow path which led to Slangenberg quarry, six testing grounds were to be connected to the quarry by a light railway. The sites of these were found by field studies.

A high voltage cable running from Maastricht was tapped to supply electricity to the quarry and it was planned to either draw water from existing facilities or sink new wells.

A loading platform for lorries and trains was situated near the main entrance to the quarry. It incorporated several smaller platforms which were equipped with cranes and four ton trains running on light railways. The trains were used to transport the engines to and from the testing grounds.

Next to the small quarry entrance, as opposed to the main entrance, was dug out a hall which functioned as a locomotive shed locally known as the 'Star of Paris'.

The main platform served the Dutch Railway Company's main line running north-south along the valley towards Meerssen. The line served the open cast mine belonging to Staatsmijnen who had repaired an old line used in the building of the castle Schoonzicht.

The smaller quarries adjoining the platforms were used as bomb-proof petrol and maintenance stations for lorries.

Quarry entrances and airshafts had to be protected against air-raids and sabotage. Gas locks and bullet proof doors were used. It was also thought necessary to change the air-shafts into emergency exits.

The workers were housed in barracks built on the tree covered hill-side between the underground galleries and the hollow eastern path. A large labour force for manning day and night shifts had to be housed safely despite the violence of war.

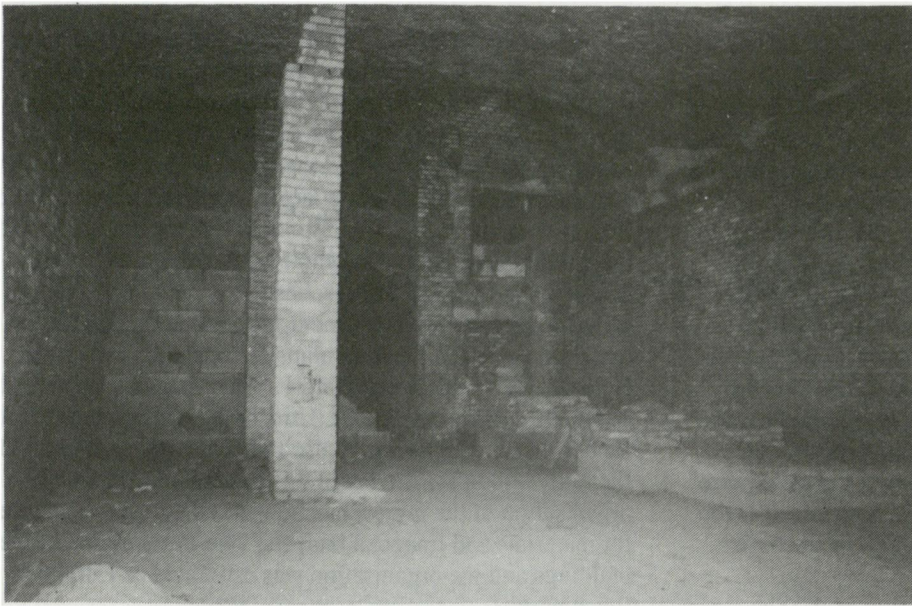


Fig. 3 HEIDEGROEVE - ENGINE ROOM MAIN SHAFT IN HEART OF FACTORY, 1986-7. Photo by author



Fig. 4 A QUARRY CORRIDOR AFTER ALTERATION (HEIDEGROEVE) 1986-7. Photo by author

Fig. 5 BRONSDAELGROEVE - BUNKER REMAINS AT MAIN ENTRANCE 1987-7. Photo by author



HEIDEGROEVE (CODE NAME: VALERIE 20)

Heidegroeve in Valkenburg has been the subject of speculation concerning its true function during the last year of the occupation. As in the case of Bronsdaelgroeve these speculations did not survive the study of documentary sources.

Even after lengthy fieldwork in 1986 it was not certain what industries were established in and around Heidegroeve in 1944. When in 1988 a large part of the underground workings collapsed it seemed that question would never be answered. However, the historical facts about Heidegroeve emerged in 1990 when important information was found in the archives.

Heidegroeve was one of the first underground quarries to be involved in operation Molch. On January 28th 1944 Organisation Todt was ordered to adapt this quarry for industrial purposes. Building started on March 15th but it is not known when production started or was scheduled to start. Since the works were nearly completed it is likely that the plant had operated at some time.

The company operating the plant was a sister company of Philips Eindhoven from Aachen in Germany; the Philips Valvo Werke GmbH. The company was required to participate in the 'Bordfunkprogramm' which was part of the 'Jägerprogramm' a scheme to increase Germany's air-power. The Bordfunkprogramm was concerned with manufacturing radio equipment for air-craft. As in the case of the Bronsdaelgroeve an investment application form for installing the company in the Heidegroeve has come to light. It dates to February 23rd 1944 and is drawn up by the company in Aachen. A certain Werner company whose office was situated in Valkenburg co-ordinated it. This application too was addressed to the Reichsluftfahrtminister. Maps indicate that the factory was installed underground by August 24th 1944 and prove that it existed when the allies liberated Valkenburg on September 17-18th 1944.

A production of 2000 Fu E 16 ZY, 2000 ZVG 16 Z and 8000 Anschlussdosen AD 11 and AD 12 per month is mentioned. (The meaning of these codes is not known but the answer probably lies in Phillips' archives in Eindhoven. These were not accessible). The production was given by the Reichsluftfahrtminister and everything produced at Heidegroeve had to be suitable for aviation purposes.

In contrast to Bronsdaelgroeve details of the costs of installing the works at Heidegroeve are not known. The total cost is estimated at 3,500,000 Reichmark - a very high figure. But the true cost was probably much higher.

Together with Heidegroeve, Roebrouckgroeve in Valkenburg was involved in the operation. This was because on the one hand Heidegroeve had no room for storage and on the other hand the Roebrouckgroeve was not suitable to become a factory because of its thin roof. Thus, Heidegroeve became exclusively a production unit and Roebrouckgroeve a depot.

It is possible to give brief details of the underground constructions.

The walls of the underground galleries were coated with a thin layer of concrete. Sprays used for toxic chemicals on farms and market gardens were confiscated for this purpose. All corridors were raised, pillar corners were smoothed down, dividing walls were heightened and at the surface the air-shafts were protected by bunkers against sabotage and air-raids. Safety was very important and fire extinguishers were placed everywhere. There was an internal and external telephone system and even a telex. The Heidegroeve had a transformer room with an emergency generator at its disposal. There was a pumping unit and a compressed-air apparatus and, from Valkenburg, a gas pipeline and water main. The quarry was amply supplied with wash-rooms and bathrooms. The drainage of the sewage ran by a 'Klaranlage' at the entrance - the existing Catacomb entrance to the Geul. The quarry had another entrance which now faces the porter's lodge entrance of the Leeuw brewery. Just like in the Bronsdaelgroeve, the temperature in the quarry was adjusted to the needs of industry by means of an air conditioning plant which was probably fed from the large bunker on the top of the Rotspark. This bunker was connected to a large corridor in the lowest level of the underground system, 46 metres below the surface. The connection was via a large shaft which came to the surface next to the bunker. The corridor was probably the most important part of the quarry - it constituted the heart of the factory.

In all, 900 employees worked day and night shifts in the factory. Accommodation and canteens for these workers consisted of three barracks in the grounds of the brewery. Other workers were settled in hotels or houses.

Although the smooth organisational talent of the German war machine is apparent the allies still put an end to their activities only six months after the project had started.

GEMEENTEGROT (CODE NAME: VALERIE 21)

It is not clear and not important what part Gemeentegrot in Valkenburg played in operation Molch since the preparation of this quarry was not planned until August 1944 and Valkenburg was liberated in the middle of September.

Gemeentegrot never became a factory but the Germans gave orders to end guided tours of the quarry and withdraw all maps and descriptions from sale. Plans for Gemeentegrot were probably more grandiose than for the other projects. However all we know is that the firm which was planned to be involved in the project was Rheinmetall-Borsig which was closely involved with V-weapons. Gemeentegrot was described as, 'unterirdische Verlagerung der Fertigung von Elektroden.' (Code 12/ A4)

The only work done before liberation were preliminary building activities such as the strengthening of pillars by placing walls at important crossings in the quarry and installing a transformer.

During the shelling preceding the liberation of Valkenburg many people took shelter in the underground galleries.

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*Transcript of paper read at the Subterranea Britannica
International Conference, at Bath August 7- 11th 1992
Translated from Dutch by Carlo Gremmen and converted to
English idiom and house style by the editor, B. O'Connor and
Sylvia Beamon.*

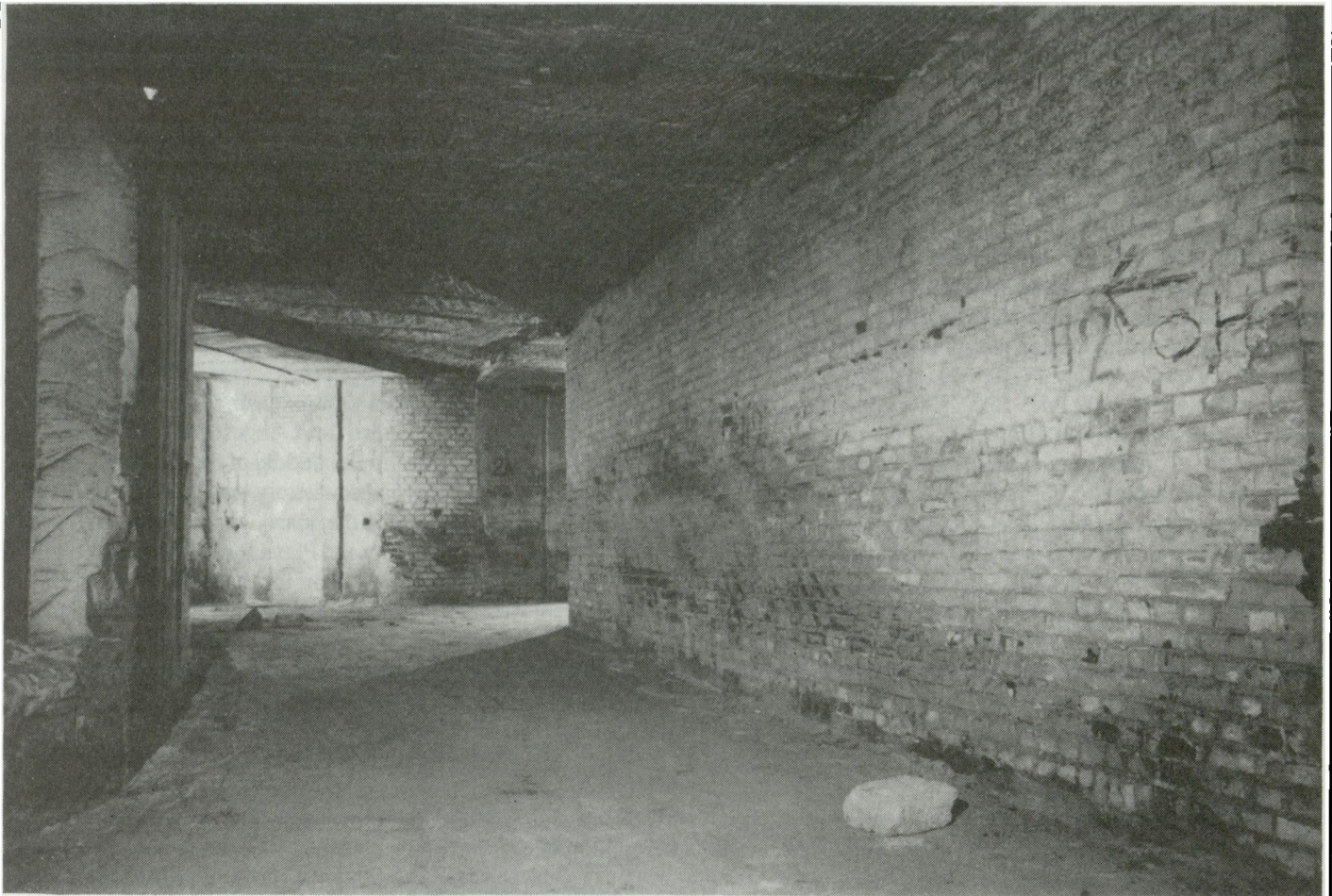


Fig. 6 BRONSDAELGROEVE - A QUARRY CORRIDOR AFTER ALTERATION, 1992. Photo by author



Fig. 7 BRONSDAELGROEVE - ARMoured DOOR JUST BEHIND A SMALL ENTRANCE, 1992. Photo by author

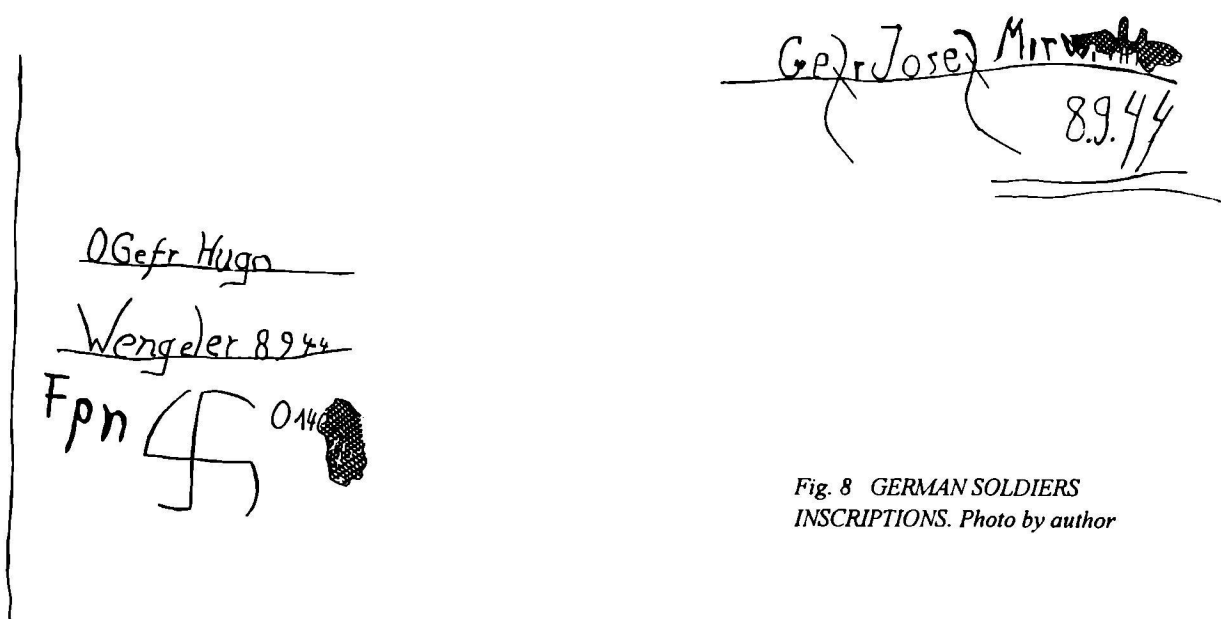


Fig. 8 GERMAN SOLDIERS
INSCRIPTIONS. Photo by author

